KNOWLEDGE
AN ILLUSTRATED
MAGAZINE OF SCIENCE
PLAINLY WORDED—EXACTLY DESCRIBED

LONDON: FRIDAY, JANUARY 6, 1882.

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THE GREAT PYRAMID.

BY THE EDITOR.

IT seems to me a misfortune that the researches made by Professor Piazzi Smyth into the proportions, position, &c., of the Great Pyramid, should have their value and interest impaired by being associated with wild, visionary theories. As De Morgan said long since, Smyth's views are "paradox of a very high order, backed by a great quantity of useful labour, the results of which will be made available by those who do not receive the paradoxes."

But it has been said (the question has been asked me repeatedly, not only in this country, but in America and Australasia), how can the numerous coincidences which Professor Smyth has shown to exist between pyramid features and the most advanced astronomy of our day be explained without supposing that the builders of the Pyramid were acquainted with a number of astronomical facts, which yet could hardly have come to their knowledge unless they were divinely inspired? Or, if some higher civilisation existed before the building of the Pyramid, and the facts in question were discovered as they have been re-discovered by modern astronomers, how is it that we have no traces of such civilisation older than the Great Pyramid itself? To these questions another has been added, especially for my own benefit, viz., this:—How can the great number of the coincidences be regarded as an argument against their significance? How can they be said to prove too much?

It appears to me that if we carefully study what the features of the Great Pyramid may be regarded as certainly proving, we shall readily distinguish the difference between the wrong and the right way of using the argument from coincidence.

We find first, in all the Egyptian Pyramids, the evidence of an astronomical plan; and in the Great Pyramid we find evidence that such a plan was carried out with great skill, and with an attention to points of detail which shows that, for some reason or other, the edifice was required to be most carefully built in a special astronomical position. It matters little at this stage of the inquiry whether we suppose the Pyramid was erected for astronomical observation or not. It was certainly constructed in accordance with astronomical observations of great accuracy, and conducted with great skill. Moreover, it is obvious that to obtain such accuracy, the building was made to serve, while it was being built, the purpose of an astronomical observatory. Just as the astronomer in our own time uses the instrument he is setting up to adjust and make exact the position of the masonry on which it stands, so the builders of the Great Pyramid used the passages which they made within it to determine, with the greatest accuracy attainable by them, the proper position of each part of it, up to the so-called King's Chamber, at least, and probably higher.

So much is certain. Every feature thus far discovered in the Great Pyramid corresponds with this theory, and some features can be explained on no other.

I have shown at some length elsewhere—but the matter scarcely needs demonstration—that the only possible way in which the Pyramid could have been oriented so accurately as it has been, was by stellar observations. Of all observations for *that* purpose, those made on the Pole-star of the time would have been the most effective. If there is a star which the astronomer observes less than another when using his observatory for that chief of all purposes to which a great public observatory, at any rate, can be applied, it is the Pole-star, simply because that star moves so slowly round its small circle. But for determining the direction of the true north point (and also for determining latitude) the Pole-star is invaluable. No astronomer who thinks over the problem at all, can fail to see that the builder of the Great Pyramid would have been driven by the requirements of his case to make just such a slant descending passage as that which opens out (now that the casing-stones have been removed) on the northern side of the Pyramid, not far above its base. It is equally certain that such a descending passage would have been directed to the position of the Pole-star when it was due north and at its lowest. The position of the Pole-star when exactly above the pole would have been just as well suited for determining the direction of the true north, but the slant passage would have had to run deeper down into the solid rock to give the same degree of accuracy, and the extra labour would have been wasted.

When, after marking the position of the base, the question of obtaining the true level came to be considered, only one method effective enough to give the required accuracy would have been available—viz., the use of water, flooding the squared space cut out in the solid rock. A difficult and costly task, doubtless, in itself, but a mere nothing considered with reference to the labour and cost to which the builders were prepared to go. For this purpose, the descending passage would have to be temporarily plugged; and as soon as the water-level had been marked at several stations on each side of the base, the plug could be removed, and the water run off into the pit which had been excavated underneath. A depth of a few inches of water all over the base would have sufficed for this purpose, but more probably a mere channel all round the base was prepared.

After thus orienting the base by aid of the Pole-star, and levelling it by using a property of liquids which was, of course, well known to them, the architects would place layer after layer, carrying towards the north the passage for observing the Pole-star, so that as each layer was placed, the work of orienting, and possibly of levelling, might be repeated, and an ever-increasing exactitude secured.

But they would know that ere long the direct pole-star observations would fail them; for the passage would pre-

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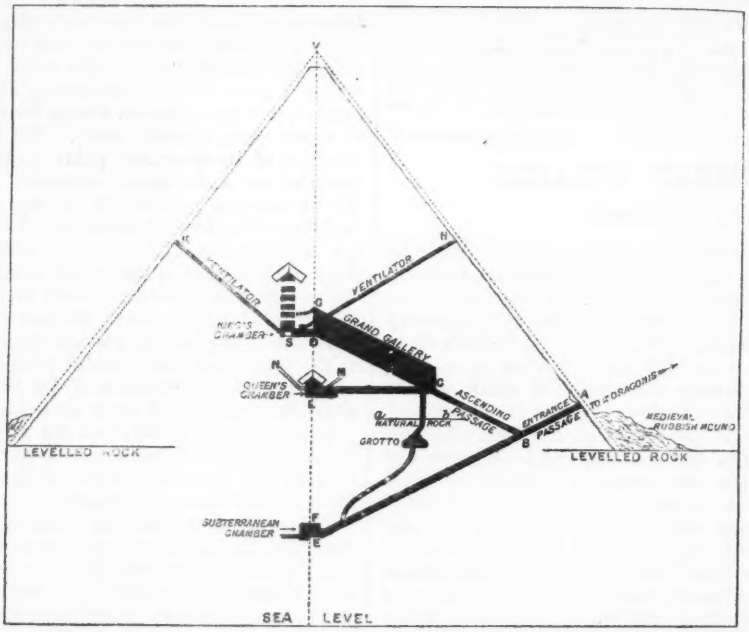
sently reach the northern face of the Pyramid. By again using a well-known property of liquids, however, combined with a well-known property of light rays, they would continue the process of orienting to a much greater height. (When I say well-known, I mean well-known to them: they were manifestly skilful engineers and architects, and as surely as they were well acquainted with the properties of matter, so surely must they have been acquainted with the mathematical relations on which the simpler optical laws depend. Possibly they knew laws more recondite; but the simpler laws they certainly knew.) Now, the plan which would quickly suggest itself to anyone knowing these laws, would be to make use of the reflected rays from a star when the direct rays could no longer be employed. We know that when a ray from a luminous object is reflected at a plane surface, the reflected ray and the incident ray make equal angles with a line perpendicular to the surface at the point of incidence, and are also both in the same plane with that perpendicular. Now, what the Pyramid architects wanted was to have a constant means of determining the direction of north and south—in other words, a constant knowledge of the position of what modern astronomers call the plane of the meridian. They had this so long as they could observe the Pole-star when due north, through a passage opening out within the square layer they were adding to the Pyramid. When, as their work continued, this passage opened out in the part of the sloping side already completed, they could still detrmine the meridian plane if they carried up a passage through the masonry in such a direction as to contain the rays from the Pole-star after reflection at a horizontal surface, such as that of still water. For a perpendicular to the surface of still water is directed to the zenith, and the direct and reflected rays from the star (due north) lie, therefore, in the meridian plane which passes through the north and south points and through the zenith.

Now this is precisely what the Pyramid builders seem to have done, as the accompanying figure, the dimensions of which are taken from Smyth's book, "Our Inheritance in the Great Pyramid," shows. AE is the long, slant passage, which for convenience we may call the descending passage, BC is an ascending passage of exactly the same character, which, therefore, we might have presumed was intended for a similar purpose, even if the consideration of the natural course which intelligent builders would have pursued had not led us to expect to find precisely such an ascending passage here. But it may be asked how the reflected rays from the star were obtained? Nothing could have been simpler. The very same process which had been applied in levelling would be all that would be needed here. If the descending passage were for a time (a day, or even an hour would suffice) plugged at B, and water poured in so as to partially fill the angle thus formed at B, the surface of that water would reflect the rays of Alpha Draconis up the ascending passage BC. The direction for the south line thus indicated could be marked, and then the plug left to slide down to the subterranean chamber.



Once a year (supposing one layer of stones added each year, as Lepsius surmises) would have sufficed for this operation.

Not only do we thus find a natural and perfect explanation of the circumstance (hitherto unexplained) that the ascending passage is inclined at the same angle to the horizon as the descending passage, but precisely as we might expect from a true theory, we find that other points of difficulty have here their explanation. It is obvious that at B the casing stones of the descending passage would have to be very closely set and carefully cemented, so that the water used, year after year, in obtaining the reflected rays, might not percolate through and do mischief. Now, just here, we find the stones of the descending passage arranged with greater precision and made of better material. "Why," says Smyth—who notices everything, but seems always to insist on some forced explanation—"why did the builders change the rectangular joint at that point, and execute such unusual angle as they chose in place of it,

in a better material of stone than elsewhere, and yet with so little desire to call general attention to it, that they made the joints fine and close to that degree that they escaped the attention of all men until 1865 A.D.?" "The answer came from the diagonal joints themselves, in discovering that the stone between them was opposite to the butt end of the portcullis of the first ascending passage, or to the hole whence the prismatic stone of concealment through 3,000 years, had dropped out almost before Al Manoun's eyes. Here, therefore, was a secret sign in the pavement of the entrance passage, appreciable only to a careful eye and a measurement by angle, but made in such hard material that it was evidently intended to last to the end of human time with the Great Pyramid, and has done so thus far." In other words, the stones were thus carefully fitted that they might be a sign to Prof. Piazzi Smyth and the pyramidalists in 1865, just as the descending and ascending passages were all to be signs. It may show great want of taste to say that all these features indicate the builder's plan, and were in no sort intended for the benefit of remote generations of men belonging to an alien race; but it seems a long way more natural.

At any rate, it is certain that men having no knowledge of the telescope, and no means of securing accuracy of direction as our astronomers do by *magnifying*, would have adopted precisely such plans as thus far seem most clearly indicated in the Pyramid structure, making long passages in solid materials, and where necessary, changing the lines of sight by simple reflection. When we consider that this would be their natural course, and that even minute details of structure (some hitherto unexplained) correspond with the theory that they adopted this course, the conclusion seems fair that the theory is a sound one. Of course, it cannot be acceptable to pyramidalists, who prefer to believe that the labours of the Pyramid builders were directed by architects knowing all that is now known in science, and more; but we are, at least, saved from the incongruity of assuming that these wonderously-gifted architects were idiotic enough to adopt the blundering plan assigned to them—hiding away for preservation their sacred symbolisms and prophetic teachings, in a building so constructed that its interior could only be reached by being forcibly broken into, and would as a matter of fact be never properly measured until it had lost in great part the perfection of form on which its value for the supposed purpose depended.

This will appear still more clearly when we consider the great gallery, which to the astronomer is the most obviously astronomical part of the building, but to the pyramidalist is a sort of "Zadkiel's Almanac" in stone.

FOUND LINKS.

By Dr. Andrew Wilson, F.L.S., &c.

PART I.

AS the question of "Missing Links" appears to be exciting a considerable amount of attention amongst the readers of KNOWLEDGE, I have thought that a paper or two on the general aspects of the beings that link together distinct groups of animals, may prove interesting and instructive to reflective minds. It is very necessary that in the first place we should remember the special form which the rational demand for such "links" should take. I have already shown, for example, that there exists no necessity or demand whatever for any theoretical link, either between man and any existing ape, or between man and any extinct ape. Such a demand is simply the outcome of an ignorance both of natural history at large, and of evolution also; and, as often as not, such ignorance is of the most prejudiced type. That which the evolutionist and naturalist desire to know, is the nature of the forms which, on the theory of "development," must have connected the human *root-stock* with the pre-human *root*. The connection, or "link," cannot be sought in the existing world. It must be obtained, if ever it comes to light at all, from the world of fossil life, and from the stores of life-relics which the geologist is year by year adding to our stores of knowledge. It is true that Nature is not bound to furnish us with "links" because we see a logical necessity for their existence. But all analogy leads us to expect that such "links" once existed; and I wish now to describe certain interesting examples of such *intermediate forms*, as they are called, culled from varied groups of the animal world. In a word, if I am able to show that we possess at present in the world around us certain animals which undoubtedly connect distinct groups, I may claim the strong support of such examples in favour of the idea that "links" that are now "missing" where we desire their presence, once did exist.

Lepidosiren annectens, or Mud-fish, showing the limb-like fins.

One of the most curious groups of fishes is that named by zoologists the *Dipnoi*. This name means "double-breathers," and the significance of the name will become apparent later on. Of this order of fishes, there are two chief examples. The *Lepidosirens*, or "mud fishes," found in the rivers Amazon and Gambia, form the first of these examples; whilst a curious fish, occurring in Australian waters, and known as the *Ceratodus*, or "Barramunda," represents the second type. This latter fish is the "Jeevine" or "Teebine" of the Australian natives. Now, in looking at either of those fishes, the observer would never for a moment suppose that they presented any features out of the common. Yet a very slight acquaintance with natural history lore proves the singular nature of their position in the fish-class. Everyone knows that fishes breathe by gills; that they are cold-blooded; that their "limbs" are represented by certain of their fins (the "paired" fins); and that their bodies are covered with scales. If we add to these facts the declaration that fishes possess a heart consisting of only two chambers, we shall have nearly completed our definition of the fish-type; and we might add, lastly, that the nostrils in fishes are typically closed pockets, and do not, as in higher animals, open backwards into the mouth. It is necessary for our present purpose to point out that most fishes possess a singular sac or bag, lying just beneath the spine, and called the *swimming-bladder*, *air-bladder*, or *sound*. From the "sound" of the sturgeon we obtain isinglass; and in a herring, for example, the "sound" may be seen as a silvery, glistening bag, which is removable along with the other organs of the fish when it is "gutted." This bag contains gas, and its use is that of serving to alter the specific gravity of the fish—that is, to render (by compression or expansion of the gas) the body of the fish heavier or lighter than the surrounding water. It thus enables its possessor to readily rise or sink in the medium in which it lives. The air-bladders of all fishes, as Dr. Günther tells us, at first open

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into their digestive systems by means of a tube or duct. But in many fishes this tube disappears, leaving the air-bladder a closed sac (as in the cod); or the duct may persist, and place the sound in communication with the digestive tract, as in the sturgeon or herring. Again, the air-bladder may be a simple and single sac; or it may be variously divided, and its interior may be smooth or may be divided into cells. We shall presently see that in the mud-fishes and the "Jeevine," this structure assumes a form and function for which its variations in common fishes in some measure prepare us.

INTELLIGENCE IN ANIMALS.

IT may be objected that in cases such as those we considered last, the animal has merely imitated an action which it has seen performed by others, and has subsequently learned to associate the action with its ordinary consequence. Apart from the consideration, however, that although in any single case such an interpretation might possibly be correct, it would be most improbable that it should explain all cases in which cats or dogs have used knockers or rung bells in the usual way, cases may be cited in which animals have devised a way of their own for producing such signals. Thus Mr. E. L. Layard, of the British Consulate, Noumea, relates the following case in which a cat acted in a way which can hardly be explained, save by assuming that she reasoned:—"Many years ago," he says, "we lived in Cambridge, in Emmanuel House, at the back of Emmanuel College. The premises were partly cut off from the road by a high wall; the body of the house stood back some little distance. A high trellis, dividing off the garden, ran from the entrance door to the wall, in which was another door, or grate. A portion of the house, a gable, faced the trellis. . . . . We were, after some time of residence, extremely troubled by runaway rings, generally most prevalent at night, and in rainy, bad, or cold weather, which was a great annoyance to the servant girls, who had to cross the space between the house and the wall to open the outer door in the latter, and were thus exposed to wet and cold." The annoyance became so great, that Mr. Layard and a cousin watched behind the trees on 'Jesus' piece,' armed with stout ash saplings, wherewith to administer a sound thrashing to the ringer, whomsoever he might be. But though the rings continued, no one pulled the handle. Hence the theory of ghosts was naturally suggested, but Mr. Layard, having brains, rejected that interpretation. At length chance cleared up the mystery. "Being ill," he says, "I was confined to the wing facing the trellis, and one miserable, blowing, wet day, gazing disconsolately out of the window, espied my favourite cat—a singularly intelligent animal, much petted—coming along the path, wet, draggle-tailed, and miserable. Pussy marched up to the house-door, sniffed at it, pushed it, mewed, but, finding it fairly shut, clambered up to the top of the trellis, some eight or ten feet from the ground, reached a paw over the edge, scratched till she found the bell-wire which ran along the upper rail from the wall to the house, caught hold of it, gave it a hearty pull, then jumped down, and waited demurely at the door. Out came the maid; in rushed puss. The former, after gazing vaguely up and down the street, returned, muttering 'blessings,' no doubt, on the ghost, to be confronted by me in the hall. 'Well, Lydia, I have at last found out who rings the bell.' 'Lard, master, ye haven't, surely'—she was broad Zumerzetsheer. 'I have; come and see. Look out of the breakfast-room window, but don't show yourself.' Meanwhile I went into the drawing-room, where Mrs. Puss was busy drying herself before the fire. Catching her up, I popped her outside of the door and ran round to my post of observation. Puss tried the door, and mewed, thinking, probably, someone must be near, and, after waiting two or three minutes in vain, again sprang up the trellis and renewed her attack on the bell-wire, of course, to be immediately admitted by the delighted maid, who this time did *not* cross the yard, nor ever again, I fear sometimes to the inconvenience of visitors, if puss was waiting for admission."

In this case it is possible that the cat may have only discovered by accident that the bell-wire could be reached in the way described. This is Mr. Layard's explanation. He considers that puss, in clambering up the trellis to the house-top, accidentally moved the wire and caused the bell to ring. It seems at least as likely that she noticed the wire moving when the bell was rung, and afterwards deliberately moved it to produce the desired effect. But in either case, it is clear that neither instinct nor mere imitative faculty can explain the cat's action in this case. In passing, I may remark that the imitative faculty, which some regard as a merely automatic quality, seems to me far better explained as the result of reasoning, though, of course, the reasoning is not of a very high order; an animal seeing a man perform some action, infers that some advantage is to be gained by the action, and repeats it in the expectation that some good result will follow, though without knowing what this may be. However, in the present case, there was no imitation, nor certainly could any instinct have been in question. Mr. Layard mentions other cases, of which the same may be said. "I have known dogs shake a door violently," he says, "to attract attention and be let in. A dear old spaniel of ours at the Cape used to rattle the empty bucket if he was thirsty, and then come and look in our faces. My horse will come up from his pasture to the pump in the yard, and whinny till someone gives him water. . . . . Surely all this is abstract reasoning," he proceeds. "These things are not taught them, and they do not do all of them even by imitation. I don't go to the pump and whinny if I want drink! nor rattle a bucket! No! they come by a process of mental reasoning, and I am convinced all animals have it to a certain degree, more or less."

There have been cases which have afforded opportunity of noting the behaviour of an animal when first some new experience has occurred to it, and (as it would seem) new ideas have been suggested. Such cases are of extreme importance in determining whether animals really reason or not; because it must be admitted that in some instances where animals have appeared to reason, the action noted may possibly have originated, in the first instance, by accident, and have been continued subsequently as a mere habit. It is rather unfortunate that the only animals which we can observe under favourable conditions—domestic animals, and those which, though not domestic, affect the neighbourhood of houses—are not those whose cerebral development is of the highest order among animals. If monkeys were commonly domesticated (which would, for other reasons, be by no means desirable), we should probably have a number of far more striking and convincing instances of animal reasoning than we at present possess, for nearly all monkeys are far higher in cerebral development than the most sagacious dogs, while horses, cats, rats, &c., are lower than dogs in this respect. Still, if we remember that whatever evidence we obtain from the behaviour of dogs and cats must be regarded as suggesting, for this very reason, a powerful argument *à fortiori* as to the reasoning faculties of monkeys, and especially of the higher orders of simians, we may be well satisfied with

such instances as have been adduced above. The following case, showing how a cat reasoned out the meaning of a phenomenon brought for the first time under its notice, seems to afford decisive evidence of the capacity of animals to deal with cases when neither instinct, habit, nor imitative faculty can afford them any assistance:—A household cat was observed to enter a bedroom which was being cleaned at spring-time: a looking-glass stood on the floor, and Tom, on entering, found himself confronted by an image which he naturally supposed to be another cat, an intruder on his domains. He made hostile demonstrations, which were presently followed up by a rush at his opponent, who, nothing loth, seemed to rush also at him. Finding an apparent obstacle to his vengeance, Tom ran round behind the glass, where he found no enemy; so he came again to the front. Here he again found his foe, on whom he again made an onslaught, only to be similarly foiled. He repeated this two or three times, applying manifestly the inductive method to the problem before him. The result of these experiments was to suggest the theory that the cat in the looking-glass, if actually existent, was unlike those specimens of the feline race with whom Tom's experience had hitherto made him acquainted. These repeated failures must have a meaning, Tom seems to have reasoned. Either he was the victim of some illusion, or the cat behind the glass was of altogether exceptional activity. But, however active that cat may be, Tom proceeded to reason, he cannot be on the further side and yet not on the further side at the same moment of time. If, then, I look at him and see him to all appearance on the further side, while at the same time I feel for him there with my paws and find him not there, then the cat in the glass must be a mere fraud. No sooner was this *experimentum crucis* devised by the clever cat than it was put into execution. Tom deliberately walked up to the looking-glass, keeping his eyes fixed on the image; then, when near enough to the edge, he reached out carefully with his paw behind the glass for the supposed intruder, whilst with his head twisted round to the front he assured himself of the persistence of the reflection. He also must have recognised, what the narrator of the story seems to have overlooked—that the looking-glass was not, as it seemed, transparent, for the paw with which he was feeling about for the other cat was not visible, though the supposed intruder remained in view all the time. The apparent presence of the feline foe, though the feeling paw could not be seen, satisfied Tom fully. "The result of his experiment," says the narrator, "satisfied the cat that he had been the victim of delusion, and never afterwards would he condescend to notice mere reflections, though the trap was more than once laid for him." It would, by the way, have been worth while to try whether a looking-glass without a frame deceived him after he had discovered the meaning of an ordinary mirror, or whether a cat placed on the other side of a transparent framed glass would be at first mistaken for a mere reflection—his conduct in either case being carefully watched. A cat which had shown such excellent capacity for reasoning was worth experimenting on.

Whether we suppose that the cat of the preceding narrative judged of the position of his supposed foe solely by sight, or may partly have been influenced by the sense of sound (very slightly, in any case), it must be admitted that he showed a fitness for original research which some amongst ourselves might be found wanting in, if we may judge from their actions in certain cases. But it is an interesting question how far an animal may really be deceived by the image of another animal, or of some object in which the animal observer takes interest. There are stories of birds pecking at painted fruit, and the like, of which some are unquestionably apocryphal. When we remember, too, that some savages fail utterly to understand the meaning of pictures,* even of the most familiar objects, we may well doubt whether animals can possibly mistake a painted figure for a real object. Yet there are some stories which seem to show that animals certainly recognise pictures of persons, animals, or objects familiar to them. It would almost seem as though such cases could only be explained as depending on the exercise of a certain amount of reasoning power, the animal inferring that, because a certain picture presents details of shape and colour corresponding to those belonging to a familiar object, the picture is in some way connected with that object, although other senses—as of sight, smell, hearing, &c.—must serve perfectly to prevent any possibility of actual deception. A letter in *Nature*, by one who remarks that "his own observations lead him to suppose that dogs very rarely take notice of a painting or any representation on the flat," seems to me especially interesting, as illustrating how the sense of sight may for a moment deceive an animal which usually trusts chiefly to other senses. "I only know of one instance," he says. "A bull-terrier of mine was lying asleep upon a chair in the house of a friend, and was suddenly aroused by some noise. On opening his eyes, the dog caught sight of a portrait of a gentleman on the wall not far from him, upon which the light was shining strongly. He growled, and for some little time kept his eyes fixed upon the portrait, but shortly satisfying himself that there was no danger to be apprehended, he resumed his nap. I have often," proceeds the narrator, "endeavoured since to induce him to pay some attention to portraits and pictures, but without success, though sometimes he will bark at his own reflection in a looking-glass. He knows it to be his own image that he sees, for he very soon tires of barking and looking."

THE HEALTH OF NAVVIES.—In view of extensive canalisation soon to be done in France, the Minister of Commerce lately consulted the Academy as to measures that should be taken to preserve the health of workmen engaged. A report by M. Colin is the result. In it he notes the persistence of a depressed vital state in certain parts of the country, especially the coast departments, which are chiefly concerned in the works projected. Marshes, with their miasma, are not the sole cause of this "impaludism" (as he calls it); but virgin soil, newly turned, emits morbid germs, whence arise intermittent fevers, &c. With regard to precautionary measures, the report specifies the following:—1. Fragmentation of work, not attacking too many points at once, not entering on a piece of work before the piece next it, begun previously, is finished. 2. Choosing strong, vigorous navvies, by preference inhabitants of the region. 3. Diminishing the time of contact with the soil. The work should be stopped at times when it is known to be dangerous—viz., July, August, and September, and in the extreme morning and evening hours. Evening vapour on plains and low-lying parts is very dangerous. Large fires should be lit in the works morning and evening. 4. Lodging of the navvies in the neighbouring centres of habitation, as much as possible in the heart of towns and villages, and on high ground, or, where near the sea, in pontoons moored at some little distance from the shore. Fevers do much less injury among workmen who reach their homes at night, than among those who remain on the works. 5. A special diet—before his work the navvy should have a substantial hot meal; preventive medications (such as arsenic, extract of nux vomica, and sulphate of quinine) have not yielded such results as recommend their use. 6. Immediate conveyance to the hospital of a navvy attacked by fever, and caution as to premature re-engagement of men discharged from hospital. 7. Early filling of the excavations, admitting water, in urgent cases, to parts which prove peculiarly infectious, and stimulating vegetation on ground newly upturned.—*Times*.

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* There are some illustrations of this in the Editor's little book called "The Flowers of the Sky," in the article relating to "Fancied Figures among the Stars."

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THE ELECTRIC TELEGRAPH.

By W. Lynd.

"God has been bountiful to the human race in this age. He has given us to see Titans enslaved by man; steam harnessed to our carriages and ships; galvanism tamed into an alphabet—a gamut and its metal harp-strings stretched across the earth, *malgré* mountains and the sea, and so men's minds defying the twin monsters Time and Space."—Charles Reade.

HALF-A-CENTURY ago railways were in their infancy, George Stephenson was bravely fighting against ignorance and prejudice, and founding his gigantic scheme which has revolutionised the world and proved one of the greatest blessings ever bestowed upon mankind.

Half-a-century ago there was not a single mile of telegraph wire in the universe.

Stephenson's name and fame have been trumpeted far and wide. Biographies without number of the great engineer have been written; only recently Dr. Smiles has given to the world his admirable "Lives" of the pioneers of railways, George and Robert Stephenson.

But, who has heard of that other Titan of the nineteenth century, William Fothergill Cooke?

The name of the man who introduced the first practical electric telegraph to this country is almost unknown outside scientific circles; yet, what a debt of gratitude we owe to the inventor of the instruments, by means of which that potent but mysterious agent we call electricity was first made to record intelligible signs which could be translated into human language! The first electro-magnetic telegraph was produced between 1820 and 1832 by Baron Schilling, of Lanstadt. Mr. Cooke was, in 1836, occupied in the Anatomical Museum at Heidelberg, preparing wax models for his father, who had been recently appointed Professor of Anatomy in the University of Durham.

It is a remarkable fact that he had no knowledge, or very little knowledge, of either physics or electricity. When Baron Schilling exhibited and explained his primitive telegraph, Mr. Cooke was so struck with the vast importance of an electric telegraph to the railways then progressing with such marvellous rapidity in the United Kingdom, that he immediately gave up modelling, and devoted all his time and energies to the realisation of his hopes. To be the means of establishing instantaneous communication by electricity between towns, particularly the great centres of commerce, was to become a benefactor of the human race. And Mr. Cooke was so sanguine of success, that he left Germany and came to England in April, 1836.

On Feb. 27, 1837, while engaged in perfecting a set of instruments to be tried on the Liverpool and Manchester Railway, he was introduced by Dr. Rogel to Professor Wheatstone, who had been devoting much of his time to the subject of electrical communication. The meeting was a happy one. The two electricians entered into partnership, and in a marvellously brief space of time the first really practicable electric telegraph was ready for trial.

There were, however, other claimants for the honour of having invented the electric telegraph as a practical reality, but there can be no question of Cooke and Wheatstone's priority in date over the other inventors, Alexander and Morse.

The first line of electric telegraph was constructed upon the Blackwall Railway in 1838. A sight of Cooke and Wheatstone's instrument, with its five needles, would surprise the telegraphists of the present day, who are used to duplex and quadruplex working!

The five-needle instrument required five wires; now four messages can be shot along one wire!

The double-needle instrument, which will be described later on, was the next improvement necessitating the employment of two wires only, and that form of apparatus can still be seen at work upon one or two of the railways in the United Kingdom.

Although Professor Wheatstone assisted Mr. Cooke, and, no doubt, contributed in no small degree to the perfection of the instruments, we are in duty bound to regard the latter as the father of practical telegraphy.

THE MAGIC WHEEL.

WE are able this week to give the series of views of a trotting-horse to which we referred last week; and to explain how the picture is to be arranged to produce a life-like effect, we repeat Fig. 1, as the two have to be considered together.

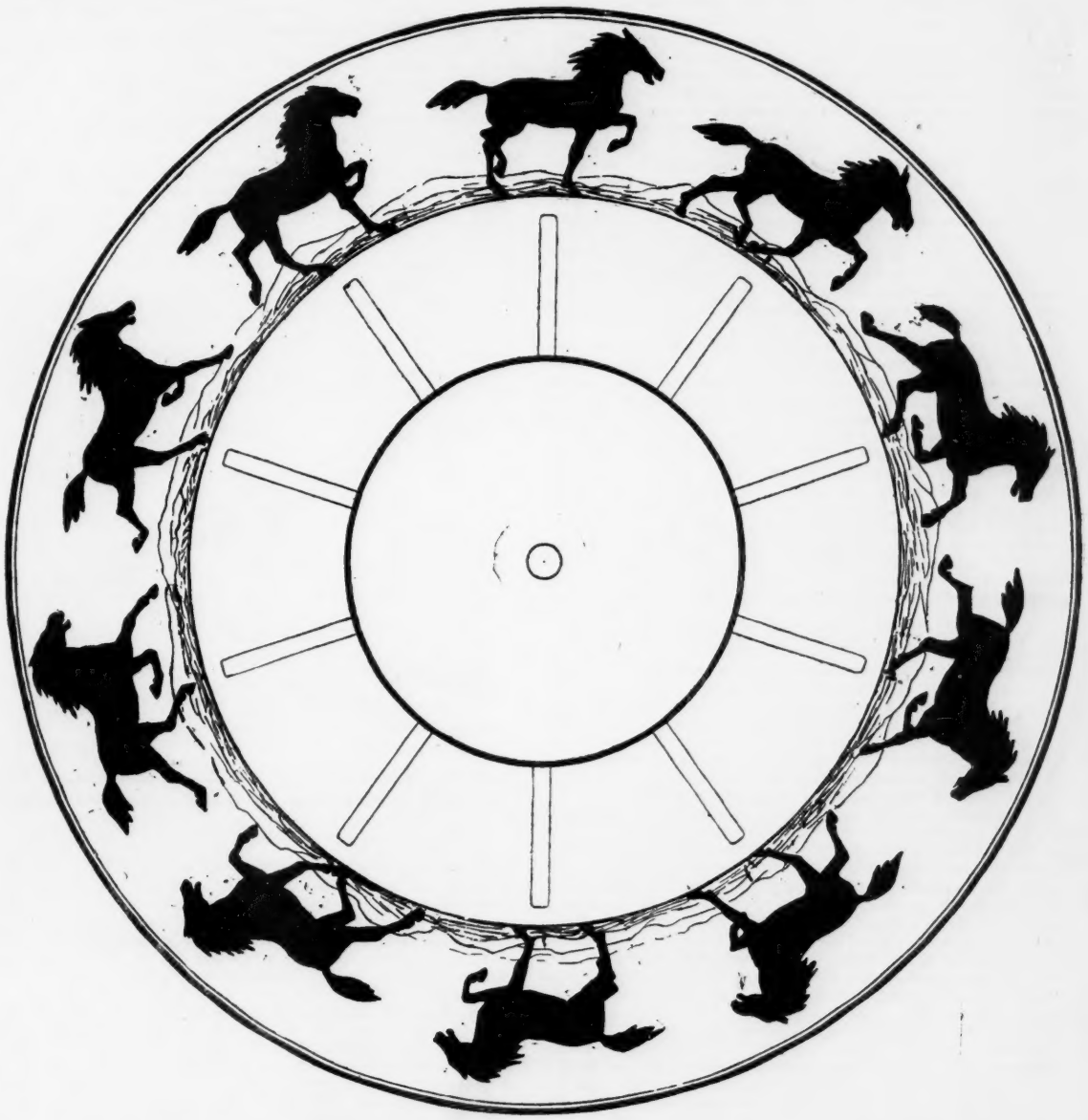
Fig. 1.

Cut out the series of views (following the outer circle) with the scissors, or carefully copy it on a separate piece of paper; and paste the circular disc thus obtained on a circular piece of cardboard. Cut out the oblong space under each figure, so as to make a series of oblong slits through the cardboard. Then fasten the wheel to a stick or handle, by means of a pin through the centre, on which it can freely turn. If now you stand opposite a mirror in the way shown in Fig. 1, and twirl round the disc before the eyes, looking through the upper slots, the horses will be seen to move as in life. The views have not been made by guess-work, as in most of the series used for zoetropes, but are from a series of actual photographs taken instantaneously at equal successive intervals of time during the trotting past of the celebrated racer, Abe Edgington. They were obtained by

Muybridge, of San Francisco. Next week, or the week after, we shall give a series showing a galloping horse.

The above views are from the *Scientific American;* but, as mentioned in our last, the series showing a trotting horse had to be modified before it could be used for the purpose of the magic wheel.

It is hardly necessary to say that the wheel can be readily made to turn uniformly by being put on a small axle, round which a string may be twined. But twirling with the hand will suffice to show how well worth while it is to provide for a more satisfactory method.



THE PLANETS AND SOLAR SPOTS.

M. DUPONCHEL considers that the maximum of solar spot frequency will not occur "as all the world, and M. Fagein particular," predict, in 1882, but not earlier than 1890. It may possibly occur as early as 1888, but far more probably will be as late as 1892. He bases this on the supposed relation between the sun spots and planetary movements, a relation which has not been established, but on the contrary, seems more and more unlikely the more the evidence is examined. Those who fondly imagine that the world is to come to an end in 1882 (the prediction of Mother Shipton—of fully equal value in our opinion—having failed for 1881) because of planetary perihelion passages, and resulting sun disturbances (also because the pyramid grand gallery is 1881·59 inches long, or ought to be), may breathe freely again, that is if they are disposed to prefer M. Duponchel as an authority to Professor Grimmer. For our own part we believe the world is quite as likely to come to an end in 1888, or 1890, or 1892, as in 1882. It has been coming to an end, at intervals of two or three years, for the last century, and probably, though we have no evidence as to details, ever since it seemed so certain to every one that the year 1,000 was to see the end of all things mundane. And so far as can be seen, one prediction in the past and for future dates has been as good as another—in other words, not one has been worth a straw.

NIGHTS WITH A THREE-INCH TELESCOPE.

UNDER the above heading we propose to furnish the beginner in astronomy with such directions as shall enable him to employ, to the greatest possible advantage, the kind of instrument with which he will, in all probability, at first provide himself. But, be it noted at the outset, that this series of papers is not intended for the possessors of telescopes of considerable aperture, equatorially mounted * or furnished with elaborate rackwork movements in altitude and azimuth.* For the owners of such, an abundant literature is already in existence; and they, at present, have such admirable works as Webb's "Celestial Objects for Common Telescopes," Crossley, Gledhill & Wilson's "Handbook of Double Stars," Chambers' one volume edition of Smyth's "Celestial Cycle," &c. We shall presuppose nothing on the part of our readers, then, beyond an ardent desire to become familiar with the beauties and glories of the celestial vault, and trust, if we can secure their attention, to put them fairly in the way of gratifying such a high and laudable aspiration. To this end, we shall use as our text the maps of the face of the sky which appear monthly in KNOWLEDGE, although we should strongly recommend the student to possess himself of the smaller "Star Atlas" by the editor of this journal, as well.

As it is of the first importance that the workman should be familiar with the tools he has to use, we shall devote this introductory essay to a description of the telescope itself, which we will imagine to be a 3-inch achromatic one, of about 42 in. focal length, mounted upon an ordinary "pillar and claw" stand. Such an instrument, as ordinarily sold, is shown in Fig. 1, which, however, represents it as furnished with a valuable little subsidiary contrivance (to be immediately described), which the observer will have to make, or get made, himself.

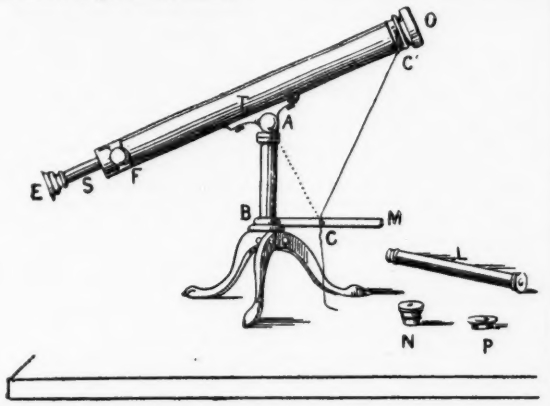


Fig. 1.

And here, albeit we are earnestly anxious to eliminate the commercial element altogether from our considerations, we are compelled to caution the student against supposing that a first-class 3-inch telescope for astronomical purposes can be made for £5, or, in fact, for any sum approaching it. The object-glass alone must cost the maker himself something like this amount. Hence, as we propose to deal with and describe celestial objects, as seen in an instrument of the highest class, we give this preliminary warning, lest the young observer should spend his money in a cheap glass, and then wonder at the discrepancy between our delineations of stars and planets and his own views of them. There is a vast amount of rubbish vended in the form of (so-called) cheap telescopes, and no tyro should ever purchase such a one without its previous examination and testing by a skilled expert. Makers like Cooke, Dallmeyer, and Wray will not imperil their great and deserved reputation by selling an inferior object glass, even to a total stranger; but instruments of unknown opticians require the most rigid trial before they can be safely bought. We shall give further on, a few tests by which the student himself may judge somewhat of the quality of his purchase. It is time, however, to turn to our figure. Here we see the brass tube T, into one end of which screws the cell containing the object glass O. Through a tube projecting from the brass disc which covers the other end of T, the smaller tube S is worked in and out by the milled head F, acting in a rack and pinion. This is for the purpose of focussing the telescope, and making the image of the object observed sharp and distinct. Into the tube S screw the eye-piece E, consisting of two lenses mounted in a short piece of tubing. Shortly, the action of the instrument is this. The object-glass forms in its focus an image of the object to which it is directed, and the eye-piece—which is really a microscope—magnifies this image before it enters the observer's eye. So much for the telescope itself. It is bolted, as will be seen, by two screws and nuts to a brass plate, which has a vertical motion, by means of the knuckle-joint at A, at the top of the stout brass pillar AB; and a horizontal one, furnished by the rotation of the whole of this top-fitting, inside the pillar. Three massive feet form its support. The arm BM shown in our drawing forms no part of the ordinary fitting of the instrument; it constitutes the subsidiary contrivance of which we spoke above, and we shall explain its use presently. L in the figure represents a terrestrial or four-lens eye-piece, which shows objects erect, and hence is used for land-purposes. It screws in at the extremity of S, just as E does. The ordinary astronomical, or so-called "Huyghenian" eye-piece contains, as we have previously said, only two lenses, and inverts, or turns objects upside-down. This, however, is obviously immaterial in a star, and this construction of the eye-piece enables us to obtain high power with comparatively small loss of light. N is another astronomical eye-piece, and P a dark cap or shade, screwing on to every eye-piece, for the purpose of observing the sun. The student is earnestly warned never to look at the sun through a telescope without first covering the eye-piece with one of these shades. When, however, we come, in a future paper, to speak of the sun, we shall describe how the solar details may be telescopically shown without looking through the instrument at all. The powers usually supplied with a telescope of the size we are describing are one terrestrial one, magnifying, perhaps, 45, and three astronomical ones, giving powers of something like 50, 100, and 180. If, however, the observer intends to devote his instrument wholly to the sky, we should advise him to replace the terrestrial eye-piece by two Huyghenian ones, magnifying 25 (for comets, nebulæ, and clusters), and 250 (for close double stars) respectively. For night use, too, a "Dew-cap" will be found indispensable. This may be made of a tin tube, bright outside and blackened within, about 8 inches long, and fitting over the object end of the telescope at O. This prevents direct radiation from the object-glass, and the consequent deposition of dew upon it. *Never wipe your object-glass if you can possibly help it.* Expose it to the heat of a fire (not too near) or of the sun, should it become heavily dewed.

A word may now be said as to the use of the bar BM shown in our sketch. It is a fact familiar to nearly everyone who has ever opened an astronomical primer (and, at any rate, to be established by a single winter night's observation of the sky from dusk to dawn), that the stars all seem to describe circles round a centre in the Northern sky, called the Pole, very close to which is situated the star we call the Pole-star. The farther we go from this centre, the larger these circles become, up to a distance of 90°, beyond which they begin to diminish again. Moreover, the point round which they turn is something over 50° above the Northern horizon (depending on the observer's latitude), so that they are all described obliquely to the horizon. Obviously, were the apparent axis of the concave celestial vault vertical, the Pole would be overhead, and the stars, seeming to describe circles parallel to the horizon, would neither rise nor set. In this imaginary condition of things (imaginary in England, for it really exists at the Poles), the mounting of the telescope shown in our figure above would enable the observer to follow a star by merely turning the telescope round the vertical axis, AB, when once that star was in the field; but a moment's thought will show that a simple movement round a vertical axis will by no means accomplish this when the star's path is described round an inclined one. The vertical movement of the telescope, we may here say, is spoken of as its motion in altitude; its horizontal motion as that in azimuth. It may require a little more attention to see that if we so tilted the axis AB that it became parallel to (or practically coincided) with the apparent axis of the sky; that then the simple motion round it would follow any star to which it was directed, from its rising to its setting. A telescope thus placed is said to be equatorially mounted. Now, the little device in our cut, for which, in its existing form, we are indebted to the Earl of Crawford and Balcarres, is intended to communicate an approximately equatorial motion to the ordinary altazimuth mounting of the instrument. It takes the form of a bar BM, extending from the base of the pillar AB. In it, at such a distance from the point B vertically under A that the angle ACB shall be=the latitude of the place, a hole is bored, and a thumbscrew (shown at C) inserted through the bar, so as to nip a light chain or thin wire tight when it is passed through the hole. The other end of this chain is fastened anywhere towards the end of the telescope at C′, and sufficient weight is put on to the eye end of the telescope to keep

* These terms will be explained as we proceed.

the chain C.C′ tight. Perhaps we may say that if the height from A to B is (as is very common) 11 in., the hole at C may be 8¾ in. from B. This will give a quasi-equatorial movement to the telescope for London and places not very far north and south of the same latitude. The use of this contrivance is very simple. The bar BM is placed due north and south (M, of course, towards the south). A star is got into the field, and the chain C.C′ stretched tight and made fast. Then the observer will find that on rotating the telescope horizontally round A, the end O will be so shackled as to constrain it to follow the given object. A few miscellaneous hints may conclude what we have to say on the telescope itself. First, the reader may wish to test it for its freedom from colour and aberration. For the first, let him turn the instrument on to the round edge (or "limb") of the moon, and first move the eye-piece within the focus by means of the milled head F, then a purple fringe should appear on the lunar limb. On moving the eye-piece outside the focus, this should give place to a green ring. A telescope that exhibits this sequence of phenomena is achromatic. For spherical aberration, focus the telescope on a tolerably bright star, with the whole aperture, and then put a diaphram of, say, 1½ in. aperture over the object glass,

Fig. 2.

Fig. 3.

and see if the star remains accurately in focus. If it does, spherical aberration is cured too. A bright star in focus with a power of 150 should present the appearance of Fig. 2, by no means that of Fig. 3, which latter indicates a practically worthless object-glass; nor should any light *haze* appear about bright stars or planets. Next week we hope to set the young observer fairly to work.

THE SO-CALLED TUNNEL-WORM.

In *La Nature*, for December 10, M. Maxime Hélène remarked that exaggerated ideas are prevalent respecting the defective ventilation of the great tunnel of St. Gothard, and in particular that the supposed development of a special parasite, the tunnel-worm, must be regarded as problematic. To this Professor F. A. Forel replies that the malady is perfectly authentic, and is due to a parasitic worm, the Duodenal Anchylostoma (the stiff-jaws of the first intestine, one might say), which attacks the mucus membrane of the jejunum and duodenum (the first parts of the small intestines), and sucks the blood like a leech. He says that Dr. Ed. Bugnion, a professor at Lausanne, has recently published a remarkable investigation, in which he has discussed the question thoroughly. He has examined forty-one well authenticated cases among the workmen in the Gothard tunnel, attacked by chloron and anæmia (ghastly paleness and bloodlessness). The presence of the tunnel-worm was established in these cases either by post-mortem examination or from the recognition of the eggs in voided matter. As for the origin of the disease, it is not, as has been thought, a new one, or produced by either the high temperature and bad ventilation of the tunnels. The worm is very common in Egypt, where it causes Egyptian chlorosis, and in Italy. Its appearance in the St. Gothard tunnel is easily explained, when we consider, on the one hand, the habits of the thousands of workmen employed there (all Italians, crowded in the villages of Airolo and de Goeshenen), and the migrations of the intestinal worm. It passes, says M. Bugnion, the first part of its existence in the mud and slime of water-pools*, and it is from drinking dirty water containing young larvæ of the parasite that the infection is received. Since the nature of the disease has been known, worm medicines have been used, and the doctors of the St. Gothard tunnel have lost no more of the patients attacked by the ailment, which had been called provisionally the St. Gothard anæmia, and which should hereafter be called, Professor Forel thinks, by the pleasing name "Anchylostomasia."

* *Le limon et la vase des flaques d'eau*, amusingly mistranslated by a daily contemporary: "the lemon and vase, part of water flasks."

SCIENTIFIC PARADOX.

Time was when itinerant lecturers made a great point of what was then called the "hydrostatic paradox," by which the weight of a pint of water might be made to burst asunder the strongest cask—but although that age has passed, yet we are not without some paradoxes which yet remain in the ordinary treatment of physics.

That steam at 100°C. should heat a bath of Calcium Chloride up to 145°C., is paradoxical at first sight; but it is an established fact, and well understood by those who are familiar with the laws of specific heat.

That getting nearer to the sun as a source of heat should result in perpetual ice, is paradoxical at first sight; but it is a fact, and well understood by those who are familiar with the complex conditions.

The following case may or may not enter this category; but after much trial, I have failed to understand the conditions.

(a.) *One Gas does not behave as a Vacuum to another.*—If I understand the books rightly, there is no difference between the pressure of two separate pound weights in a pair of scales, and the pressure of two separate units of gas (be they similar or different) in an exhausted vessel. In both cases, each presses with its own individual pressure; and in every case, the *joint-pressure* upon the sides of a vessel will be exactly as the sum of the individual tensions.

Volatile substances have different maximum points of tension, beyond which they will not volatilise. A cubic inch of water at 100°C. will evaporate into an exhausted vessel of 1,700 cubic inches capacity, and produce a pressure on the sides of 760 millimètres of mercury (or one atmosphere); and if more water be added, it will not be evaporated; while, if the pressure be increased, water in proportion would be condensed.

Such points of maximum tension for water are at 100° = 760 mm.

,,	,,	,,	alcohol	,,	1,697 ,,
,,	,,	,,	ether	,,	4,953 ,,

(b) *One Gas does behave as a Vacuum to another.*—If I understand the books rightly, one cubic inch of water would evaporate into the aforesaid vessel, equally whether it be a vacuum, or filled with air, or any other gas; so that if the vessel were previously full of both alcohol and ether vapours, their joint pressures would be 6,650 millimètres; against which the cubic inch of water would evaporate; but more slowly as the pressure increased.

In the books these two aspects are confusedly mixed up together, and perhaps a novice has not been quite clear in separately and strongly stating the paradox.

It is rather curious that Clerk Maxwell, in his treatise on "Heat," while admitting that one gas may be a vacuum to another, yet says nothing in justification of the second aspect.

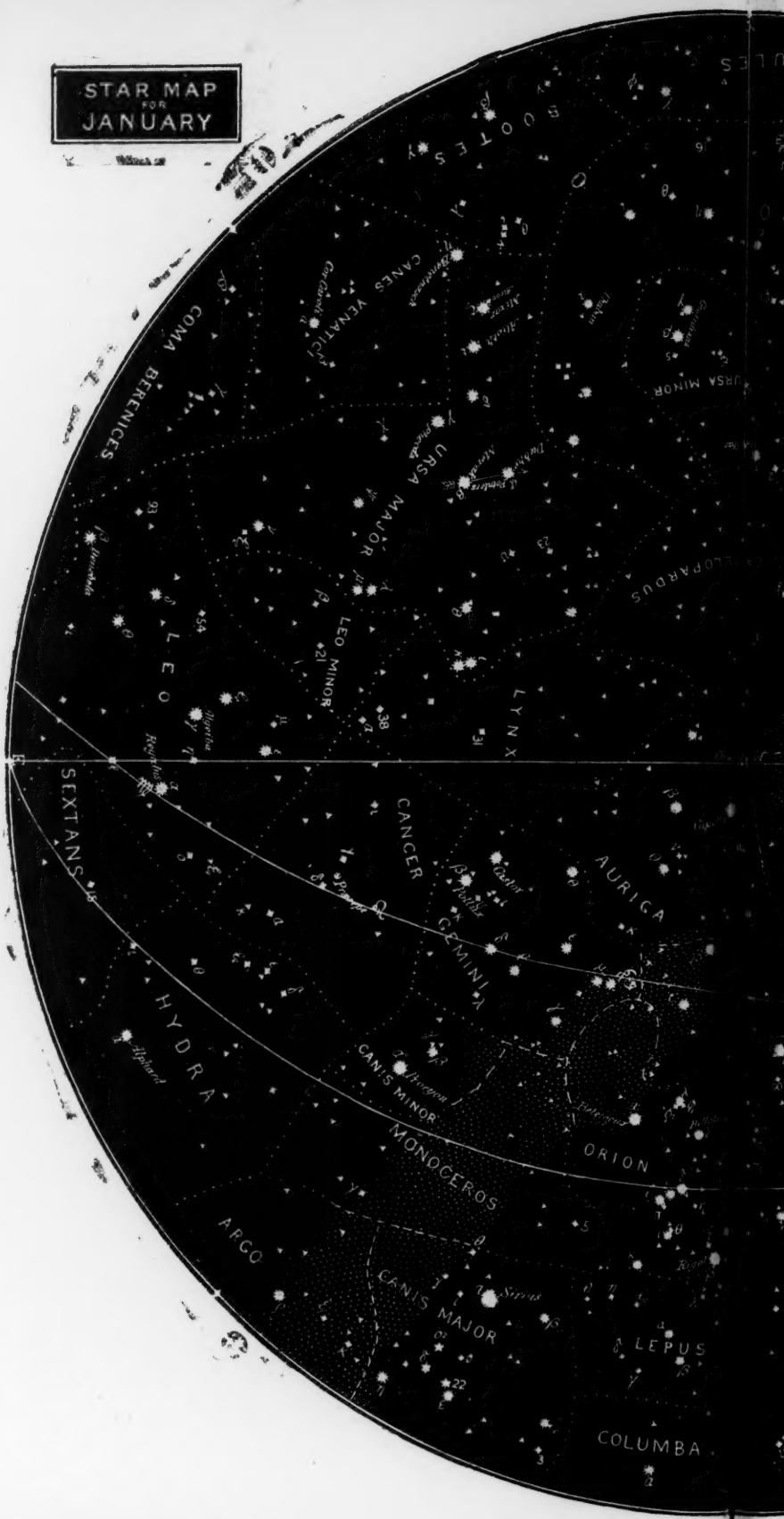
Eclecticus.

VITALITY OF TOADS.

The following passage from an old number of the "Cosmos," may interest those who have taken part in the discussion about the vitality of toads. It is an account of various experiments on this subject, by M. Victor Legrips, of Chambon. M. Legrips put some toads in chambers hollowed in the earth to the depth of sixteen inches, placing them on a tile, and covering them with a pot. Others were immured between two discs of glass in plaster cells, without access of air; and some were imprisoned in masses of mixed plaster, which touched every part of them. The first were examined monthly, and exhibited no mark of decay till towards the twelfth month, their excretions being taken as nutriment. They lived thus, on an average, for twenty-three months. The second lot, examined through the glass, presented the following phenomena:—Abundant excretions of the debris of insects and larvæ; torpor while in darkness; sparkling of the eye at approach of light; powerful efforts to escape; progressive emaciation, till death, which took place generally after fifty-six days. Among the third class some toads were living after twenty-eight months of absolute sepulture. These facts prove that the toad can live a long time without aliment or aëration; he lived longer in the chambers where his movements were unimpeded than in the cells where he could hardly change his position; but his life was very much longer when he was completely embedded in the plaster. Not being able to move, he lost nothing; and thus it will be easily comprehended that alimentation was much less necessary, and that his life, as if suspended, might continue for an indefinite period. M. Legrips states that toads are not only inoffensive, but exceedingly useful in gardens, and that he is not at all surprised at the increasing commerce in these animals, who live exclusively on worms, caterpillars, and insects, great and small, and are thus protectors of a host of useful and ornamental plants. Market gardeners will find them invaluable.

XUM

XUM



On December 31, at 10.30 p.m.
On January 3, at 10.15 p.m.
On January 7, at 10 p.m.
On January 10, at 9.45 p.m.
On January 14, at 9.30 p.m.
On January 18, at 9.15 p.m.
On January 22, at 9 p.m.
On January 25, at 8.45 p.m.
On January 29, at 8.30 p.m.
On February 2, at 8.15 p.m.

XUM

Our Star Map. — In response to the wishes of many correspondents, we show this week the star maps which would otherwise have been divided into four weekly maps, in a single star map It will be understood that the circular boundary of this map represents the horizon. The map shows also the position of the equator, and of the ecliptic, with its signs. We propose next week to give the position of the Zodiac, now most favourably situated for observation, with the motions of the planets thereon.

Letters to the Editor.

[The Editor does not hold himself responsible for the opinions of his correspondents. He cannot undertake to return manuscripts or to correspond with their writers. All communications should be as short as possible, consistently with full and clear statements of the writer's meaning.]

All Editorial communications should be addressed to the Editor of KNOWLEDGE; *all Business communications to the Publishers, at the Office, 74, Great Queen-street, W.C.*

All Remittances, Cheques, and Post-Office Orders should be made payable to Messrs. Wyman & Sons.

**** All letters to the Editor will be Numbered. For convenience of reference, correspondents, when referring to any letter, will oblige by mentioning its number and the page on which it appears.*

All Letters or Queries to the Editor which require attention in the current issue of KNOWLEDGE, *should reach the Publishing Office not later than the Saturday preceding the day of publication.*

"In knowledge, that man only is to be contemned and despised who is not in a state of transition. . . . . Nor is there anything more adverse to accuracy than fixity of opinion."—*Faraday.*

"There is no harm in making a mistake, but great harm in making none. Show me a man who makes no mistakes, and I will show you a man who has done nothing."—*Liebig.*

Our Correspondence Columns.

THE WEATHER FORECASTS.—PSYCHO.—TOADS STUNG BY INSECTS.—BOOKS ON HISTOLOGY AND THE UNDULATORY THEORY OF LIGHT.—TABLE OF LOGARITHMS.—DIAGRAMS WITHOUT DESCRIPTION.—PRONUNCIATION OF "BETELGEUX."—THE COAL AGE AND THE EARTH'S INTERNAL HEAT.—ANTIQUITY OF MAN.

[164]—The letter [124] of Mr. Spiller, on p. 140, is a very instructive one, and may well stimulate inquiry into the procedure of that rather remarkable department, the Meteorological Office. I, like Mr. Spiller, took considerable pains some time since to compare the daily vaticinations issued from Victoria-street, with the actual weather obtaining at the periods for which they were made, and with the following noteworthy result. At first I found that the predictions were very much more frequently wrong than right, and this suggested the idea that the officials were on the track of *some* law, but were merely misinterpreting it. Later on, however, I came to the conclusion, in common with your correspondent, "that they are about as often wrong as right." It is absolutely needless to point out to any one with the least smattering of mathematics, what this indicates. Put shortly, it is that equally valuable weather prophecies might be made by the simple process of tossing up a florin and calling "heads" fine and "tails" stormy. Now this suggests to me at once, as a scientific man and as a taxpayer, that the British public has a distinct right to know why it should be called upon to pay £14,500 annually for such results as these? Moreover, it is rumoured that the office is supervised by a certain "Meteorological Committee of the Royal Society," who divide £1,000 a year among themselves. One would be pleased to ascertain definitely what is actually done by these gentry for this modest little sum. The Meteorological Office exists for the benefit of the nation—not the nation for that of the Meteorological Office, and the sooner this is realized the better for all those concerned. It seems ridiculous that we should receive such accurate forecasts of gales gratis from a New York newspaper proprietor, and that we should be reading about the "calm," prophesied by our own paid servants, while those gales are howling around us. As a very humble effort towards the solution of this concluding part of Mr. Spiller's letter, I would venture to suggest *Payment by Results.*

May I say, in connection with the question put by W. H. B. (letter 126, p. 143), that three or four visits to Psycho sufficed to convince me that a small boy is concealed within the figure. Something I once observed through a powerful field-glass satisfied me of this.

Ornithorynchus (query 100, p. 145), is wrong in supposing that toads are not affected by the stings of the Hymenoptera. I have myself seen a toad stung by a wasp which it attempted to swallow, its tongue subsequently protruding from its mouth in the form of an inflated bladder, obviously causing it serious, if not very protracted, inconvenience.

If D'Artagnan (query 103, p. 145), does not mind reading a book thirty years old, he may derive an immense amount of information from Quekett's "Lectures on Histology." It was originally published by Bailliere; but one of the second-hand scientific booksellers would be the likeliest place to procure it now. Dr. Lloyd's "Elementary Treatise on the Wave Theory of Light," published by Longman's, is excellent too, for the purpose for which he requires it.

To the list of books of Logarithms, given on p. 102, I should like to add Cape's "Mathematical Tables," published by Longman in 1860 (3rd edition), as the most convenient 6-figure set with which I am acquainted. The arrangement is excellent. In the trigonometrical tables the successive differences are given for 100″ instead of 60″, thus saving a quantity of calculation. I use these in my observatory, and Chambers' in my library.

May I venture to suggest that Mr. Thorp's drawings on p. 100, by themselves, are scarcely sufficiently explanatory of the instruments they represent? Notably Fig. 2, in the absence of verbal explanation, fails wholly to show how an ellipse can be described by the piece of apparatus delineated. It looks as though it must draw a circle—and nothing else.

In answer to query 107 (p. 167), astronomers, in practice, always pronounce the proper name of (*a*) Orionis "Bételjews."

"Ignoramus" (query 110, p. 167) should obtain and carefully read through that part of Page's "Advanced Text-book of Geology," which treats of the Coal Measures. It is not now supposed that the internal heat of the earth had anything to do with the production of the carboniferous flora; in fact, it is a grave question whether such flora was, in any legitimate sense, tropical at all. A humid and equable, rather than a tropical climate, would seem to favour the type of vegetation of which our coal measures are composed. The earth's superficial temperature is quite unappreciably afforded by her internal heat (Fourier says $\frac{1}{17}$th of a degree), such surface temperature being practically wholly derived from the sun. This influence extends to a depth varying from 60 to 90 feet. Downwards from this stratum temperature rises 1 degree for every 60 to 65 feet; so that at a relatively short distance from the earth's surface, it would seem that the most infusible rocks must be molten. Possibly, the sun may one day cool down, and the earth with it, but it will not be in "Ignoramus's" time, or mine either.

Any one reading the isolated words quoted in inverted commas from Sir Charles Lyell in reply 84 (p. 168), will imagine that he did not believe in the great antiquity of the objects discovered by Mr. Horner in Egypt. Those who have been misled into this belief had better read Chapter III. of Sir Charles's own "Antiquity of Man," as recommended by "Kemp" in the preceding answer.

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

A CORRECTION: DATE OF MENES.

[165]—I perceive that "A Member of the Society of Biblical Archæology" quotes Mr. Stuart Poole as an authority for the date B.C. 2717 for the period of Menes. Permit me to say that Mr. Stuart Poole has long since abandoned that position in favour of a much more remote epoch, as may be seen by reference to his articles in *The Contemporary Review* for 1879.

ANOTHER MEMBER OF THE SOCIETY OF BIBLICAL ARCHÆOLOGY.

PERSONAL IDENTITY *versus* TATTOO MARKS.

[166]—Am I right in understanding that, owing to the Physiological waste and decay, our bodies virtually change in every part, so that our bodies to-day are not the same bodies seven years hence? If so, may I ask the following:—When a boy, I tattooed my arm with Indian ink; my body must have changed four times during that time; the design is as distinct and permanent to-day as ever. Will some of your correspondents kindly enlighten me upon this subject?—Yours, &c. WALTER H. MAGUIRE.

Dec. 5, 1881.

P.S.—I wish your valuable journal every success.

THAWING ICE.

[167]—In a book which I have—a translation from the French of Professor A. Cazin—the following experiment is described:—

"Take a piece of clear ice and place it so that a pencil of sunlight, condensed by a lens, shall enter it parallel to the planes of congelation; then with a microscope, placed at right angles to plane of congelation, examine the illuminated part, in which many luminous specks will appear, gradually increase in size, and send out little branches, generally six in number and of varying forms, &c."

I have tried this interesting experiment with several pieces of ice, but failed to see any traces of these beautiful little branchlets. What I saw was the specks of light rapidly increasing in size, and

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of a more or less nearly-circular form. Each of these cavities contained water and a bubble (of attenuated steam, I suppose); some of these bubbles remained in the centre of their cells, but others soon (especially if the sun was hot) began to move round their cells, sometimes in jerks, at others smoothly, occasionally oscillating. I should be glad to know why I was unable to see the branchlets, and should be greatly obliged to any reader who would explain the cause of the little bubble's curious movements.

Enclosed is a drawing which will give a good idea of what I observed. The larger discs represent the cavities containing liquid, while the small circular black and white spots are the bubbles. E. C. R.

DIFFICULTY OF OBTAINING "KNOWLEDGE."

[168]—Having experienced the same difficulty as mentioned by your correspondent in No. 7, I would recommend your would-be readers to order KNOWLEDGE of their newsagent, instead of the bookseller, who, for some reason best known to himself, professes ignorance of the publication.—I am, Sir, yours faithfully,

A. GAUBERT.

[We have received several letters to the above effect.—ED.]

[169]—In reference to Letter No. 134, page 144, the fact that I have generally obtained KNOWLEDGE from my bookseller in North Shields before 9 a.m. on Friday mornings may convince Mr. Armstrong that either his booksellers or their London agents are alone to blame.—Yours, &c., GEORDIE.

"OUR UNBIDDEN GUESTS."

[170]—Surely "the great lesson to be learned" from Dr. Andrew Wilson's frightful disclosures in the last number of KNOWLEDGE, respecting tapeworm and trichinæ, is one quite different from that proposed by him, and not "thorough cooking," but total avoidance of the substances liable to be infested, is the true and sensible remedy. From the "Perfect Way in Diet," recently favourably noticed by you, it would appear that man is, by his constitution and structure, not carnivorous at all, but becomes so only through degeneration of habit. From this it ought to follow that man can attain to the perfection of his nature only by subsisting on the substances indicated by his structure. My own experience favours this conclusion. Having abstained from flesh-food for some seven years, I find the results—physical, intellectual, and other—such as to make me regret that I was not a follower of the "Perfect Way" from the first, and my experience is by no means a singular one within my own circle of acquaintance.—Yours, &c., E. M.

THE POLE STAR AND PRECESSION.

[171]—In your promised paper on the Precession of the Equinoxes, can you give us a star-map, showing the circle described by the North Pole, and therefore all the stars which have been successively Pole-stars? One meets with the statement that about 4,000 years ago *a Draconis* was the Pole-star; but no full information is given in popular books. With such a star-map as I suggest, we could find for ourselves the Pole-star for any period of the past. —Yours, &c., GEORGE ST. CLAIR.

[Will supply such a map the week after next.—ED.]

A NEW COMPARISON OF POISONS.

[172]—Notwithstanding your approval of "Technical Chemist" (Letter 102, p. 116), I venture to think he is not quite right. The allegation is that li. ce. is three times as poisonous as ba. ce.; and, while admitting that ba. ce. is poisonous, it is urged that li. ce. is often prescribed in comparatively large quantities for gout. Now, why mystify M. Richet's plain proposition? Li. ce. has 20 per cent. of metal, where the citrate has probably much less than 7 per cent.; besides, iron and mercury may be very poisonous in one form of combination, and very innocuous in another. S. E. P.

SOUND.

[173]—"C. T. B." (query 60, p. 125) may be right in saying "the lighter the weight, the better does a body transmit sound"; but only in conjunction with a mysterious function of elasticity, which figures so largely in scholastic formulæ and ideas. We know that air transmits sound in round numbers, about 1,000 ft. per second; water 4,000 ft.; and some dense woods and metals, 10,000 to 15,000 ft. per second. A great chemist on the Continent is holding up to ridicule a kind of weekly anthology of modern chemical utterances; with some such feeling I would try to fairly paraphrase the sound contentions of "T. J. H." (query 14, p. 123). The condensation augments the elasticity by the heat generated in the condensation of particles. The rarefaction augments the elasticity by the cold generated, and also by the separation of particles. The heat generated remains there to increase the velocity. It is because the heat generated in the condensation augments the rapidity of the condensation, and the cold developed, augments the rapidity of the rarefaction, that the heat and cold both help to augment the velocity of the sound wave. ECLECTICUS.

THE MAGNETIC NEEDLE.

[174]—There is no attraction of the kind "W. H. P." (query 90, p. 123) seems to suppose. The affection is one rather of polarity or deflection. Let "W. H. P." imagine a globe with convolutions of wire conveying electricity round the equator, representing *actual* earth currents, then he will find that particles of air or iron will have a binary polarity induced in them, at right angles to the direction of current. There will be a field of magnetism where the lines of force point N. and S., or to the two poles; but there is no tendency to movement or change of position of the polarized medium.

In order to remove any ambiguity about these poles, it may be well to explain that this same field of force subsists all round any wire conveying a current. Here, then, we have a circular field of force with no poles. Let (*a*) be a section of the wire carrying a current downwards or from the point of view; then small unmagnetized needles (with no directivity) would have polarity induced in them such as to point east, west, north, or south, as per diagram. If the current flow upwards, these polarities would be reversed.

In very many cases, arrows indicate motion or a tendency to motion. In this case, they only convey the idea of polarity in the media, where iron is immensely more sensitive or conductive than air. ECLECTICUS.

BUTTERCUPS—BEES AS FLOWER FERTILISERS.

[175]—In answer to "West Riding," I should like to remark that where grasses, daisies, and docks predominate, I have never observed that the vegetation was "thick and matted;" I was alluding rather to tangled hedgerows and overgrown spaces. "West Riding" can hardly expect me to explain the whole philosophy of leaves, among other things, in a single short article. Oddly enough, my intention, before seeing his letter, was to write a paper for KNOWLEDGE on the foliage of daisies and plantains, and, with the Editor's kind permission—[Gladly accorded.—ED.]—I will now do so shortly. The subject is one which I have long been observing.

Mr. Donbavand is mistaken in supposing that bees never visit

buttercups. Whether the hive-bee in particular does so, I cannot say with certainty; but I am sure that the common bumble-bee is often found among the flowers. Of course, other insects also aid in fertilising them. GRANT ALLEN.

NUMERICAL COINCIDENCES.

[176]—This numerical disease is not confined to the Pyramids and astronomy.

M. Berger, referring to the failure of Prout's theory, that all the atoms might be multiples of the unit hydrogen, finds out that by dividing the chief elements into five groups, then all are multiples, or submultiples of five specified values, which are notated H, D^1, D^2, D^3, and D^4. He attaches much value to this classification, but admits that "these five divisors have no value or relation among themselves."

A professor of Harvard College, America, professes to see farther into a brick wall than M. Berger, under the attractive title, of "Atomic Phyllotaxy," to wit:—

Berger.			Phyllotactic.		
H	= ·9997	=	1-16th of O	=	·998
D^1	= ·769	=	5-13th of D^2	=	·768
D^2	= 1·995	=	1-8th of O	=	1·996
D^3	= 1·559	=	$(\frac{1}{4} \times \frac{2}{3})^3$ of O	=	1·559
D^4	= 1·245	=	5-8ths of D^2	=	1·247

ECLECTICUS.

THE SUN'S CONSTITUTION, AND ORIGIN OF SUN-SPOTS.

[177]—I have noticed that in many modern text-books of astronomy (especially those published since 1870), doubts are expressed as to the truth of Herschel's theory of the sun's constitution (to which for so many years astronomers had inclined) viz., the theory of a *comparatively* cool nucleus, enclosed in two concentric shells of matter, analagous to our clouds, of which the outer forms the visible surface of the sun. In your "Poetry of Astronomy" you say, "We know the sun to be infinitely more complex in structure . . . . than it was formerly supposed to be. . . . . We have learned that . . . . the glowing veil of air hides by day . . . . the largest (though not the most massive) part of that sun. . . . ." Would you give us a paper in KNOWLEDGE on this most interesting of astronomical subjects, as in your books you do not explain what you intend to convey by the above? I presume you speak of the sun's chrom[at]osphere, corona, and the atmosphere discovered by Professor Young. I should be much obliged if you would insert my letter, as I should much like to see correspondence on this most interesting subject. Discussions on it would be far more interesting than those on Anti-Guèbre's absurd theory. Hoping for the favour of insertion,—Believe me, yours, &c., VIGNOLES.

[We shall be only too glad. Our fear is lest readers should think we give too much space to our own subjects.—ED.]

SINGULAR PROPERTY OF NUMBER 4.

[178]—The following is a solution of this interesting property of numbers for the number 19.

$$\underline{|4} - \left(4 + \frac{4}{4}\right) = 19$$

H. SNELL.

[Functional 4, or the products of the numbers 1, 2, 3, 4, can hardly be regarded as a fraction of 4 in the sense required for the solution of this little problem. Neither can ·4, or 4 divided by 10.—ED.]

SMALL TELESCOPES.

[179]—As I am about to purchase a telescope for astronomical purposes, I am at a loss whether to invest in a refracting or a reflecting telescope. The work I want it for is the course specified in Webb's "Celestial Objects," at least as far as an ordinary 3¼ in. refractor, with powers of 70 to 200, would suffice; but I do not know whether to purchase a refractor of this aperture, or a reflector with corresponding powers. I am not prepared to invest beyond £15 for the instrument, and should feel extremely obliged if you could advise me as to what to buy. By so doing you would infinitely oblige, yours truly, W. RIDD.

VERMIN.

[180]—I should be glad if you would insert an article in your valuable paper upon the uses of those apparently useless insects, bugs, fleas, flies, roaches, &c., or if you could name a good book upon the subject.

Hoping that your paper will have the utmost success.—Yours,
AN AMATEUR.

[We hope our readers will not say, with Mr. Pecksniff:—"Oh, vermin! Oh, bloodsuckers! Begone! abscond!" —ED.]

MALE AND FEMALE HEADS.

[181]—It appears to me that in the correspondence on this subject, too little prominence is given to the effect of long-continued training in the development of the male head and its faculties, while, in estimating female powers, few writers or speakers care to remember that, till within the last few years, a liberal education was beyond the reach of average women. Among the uneducated classes, is it not frequently the woman who is the manager, the shrewd head of the household? It would be fairer to measure relative power where both sexes are comparatively untaught, rather than in the classes where the men have for generations had the benefit of schools and colleges, while their sisters were indulging in "vapours" and "sensibility." Of course, there are plenty of fashionable fools still (whose waists are as small as their sense), but it would be rude to suggest that they might easily find their parallels among the loungers in St. James's-street, especially during the Derby week. I heard lately of a singular case of growth of the head of a student who has begun his work somewhat late; and, *pace* the artists, I hope that in a few generations our women's brains may show the result of broad education. If it is true that sons take after their mothers, the future Englishmen should not be the worse for increased intelligence and culture among those who make their homes.

M. McC.

PHRENOLOGY AND THE BRAIN.

[182]—I was very much pleased with your remarks on phrenology in "Answers to Correspondents" the other week, and must certainly concur with them. I think that the whole drift of modern physiological experiments tends to a disproval of the conclusions of phrenology. Dr. Ferrier's experiments, for instance, have shown that the individual convolutions of the brain are separate and distinct centres, and that "in certain definite groups of convolutions, and in corresponding regions of non-convoluted brains, are localised the centres for the various movements of the eyelids, the face, the mouth and tongue, the ear, the neck, the hand, foot, and tail." We have thus certain definite areas of the brain superintending various motions of the body, but we can find no trace of the numerous "esses" with which the phrenological vocabulary abounds. Certain lesions, moreover, prevent the voluntary movement of special groups of muscles. J. H. H.

DARWINISM.—THE DESCENT OF MAN.

[183]—The Darwinian theory of the origin of man, of all forms of vertebrate life—that is, of all animals having a backbone and internal skeleton—is not, apparently from communications to KNOWLEDGE, so generally accepted as I supposed. There can be, then, no singularity in the apparition of another doubter.

"Vestiges of Creation" initiated the great public in the doctrines of the evolutionists. The work is a reputed hash of matter and ideas from German and French sources. The work had a great run, lived its day, died, and left no permanent impression. Mr. Darwin's unique works have influenced the entire civilised world. His profound investigations and remarkable method of developing his labours to the public gave Mr. Darwin, almost at a bound, a scientific and literary position such as few other men hold. But, with all this, I cannot reconcile myself to his theories, nor to the theories on which they are based.

I am neither biologist, nor ethnologist, nor anthropologist; I am simply one of the common herd of readers, with the difference, perhaps, that occasionally I venture on the more difficult labour of thinking. I may not have, but I presume I have, discernment enough to follow the lines of Darwin, and his co-labourers, so far as the steps of what, to me, is doubtfully the propylæum of the impenetralium that conceals the secrets of the Almighty Intellect we name Nature, and adore as Jehovah, Lord, and God.

"Vestiges" excited theologians, but the "Decent of Man" provoked them to rancour. The forcibly disagreeable, which the "Descent" is to very many, bites into the mind; the feeble slides over it. But the idiocrasy of the caste, the fenced lines of thought they habitually move in, blinded them to the actuality. They beat, and continue to beat themselves against a gross misapprehension of their own. Mr. Darwin presented his thesis as an argument to a probable conclusion; not as demonstrative of the absolutely certain. He has not arrived at a perfect induction, and makes no pretension to it, that I perceive.

Darwinism is based on the labours of the German transcendental anatomists, and on later theories by Étienne Geoffroy. Mr. Darwin elaborated on their principles by an *organon* of his own.

Geoffroy's epigrammatic enunciation, "There is but one animal, not many," involves the whole case of the evolutionists. The plain meaning of this dictum is, that all animals of the vertebrate class are formed on one plan; that all animals are a primogenial animal, repeated through time, in modified plan.

Göthe's theory is, apparently, identical with Geoffroy's; but the revelation of the German comes to us a great thought, in chaste grandeur of expression." "Comparative anatomy," he writes, "has united all organic nature under one idea; it leads us from form to forms, and while we contemplate near or far-removed natures, we rise above them all, to see their individualities in one ideal type." The entire literature of biology can show no equal to this unfolding of the transcendental idea of evolution.

This is Darwinism, in my conception of it. The "ism," then, rests on the assumption that all animals are descendants from one common ancestor.

Linked with this fundamental, there are four propositions we may expect without endangering any agreement to negative the fundamental. Indeed, save to present the case of the evolutionists in completeness, they need not have been brought in here. They are:—1. That no two animals are completely identical. 2. That offspring tend to inherit peculiarities of parents. 3. That of animals brought into existence, but a small number attain maturity. 4. That those which are best adapted to the circumstances in which they are placed, are most likely to leave descendants.

Wallace, who worked on lines conterminous with Darwin's, without being conscious of the fact, put this matter in a much better manner. He postulates:—1. Peculiarities of every kind are more or less hereditary. 2. The offspring of every animal vary more or less in all parts of their organisation. 3. The universe in which these animals live is not absolutely invariable. 4. The animals in any country (those, at least, which are not dying out) must at each successive period be brought into harmony with the surrounding conditions. "These," he affirms, "are all the elements required for change of form and structure in animals, keeping exact pace with changes of whatever nature in the surrounding universe. Such changes must be slow, for the changes in the universe are very slow."

I have, I believe, now put before you, briefly but accurately, the basis and principles of the evolutionists—of Darwinism, so called.

The first, I might say the only, difficulty of the theory is the foundation. That all animals are the issue of one common parent, and are but varied plans of that parent, brought about by time and change of telluric and climatic conditions, is a postulate that has no support in tangible fact, or appearance of fact, may be as safely affirmed as we may affirm that it is the expression of a phantasy of brains driven to overreach their powers.

What was the first-born animal, the common parent of all animals? How did it come to be, and in what form did it appear?

There is no answer to these two questions; to neither of them.

If we could rid ourselves of Pasteur's disproof of spontaneous generation, we might imagine a segregation of atoms that should acquire life, and develop into a caterpillar-like creature, which would pass through several transformations, embryonic, we may say, after the manner of butterfly development, ending in an animal of some kind, even man—the requisites, heat and food, being present. Very big things are produced from very small germs. Admit a beginning of this kind, we admit probability of innumerable various organs, and so account for every distinct animal in creation; for the endless kinds of insects, and the living myriads of the sea. In reality, the admission would put us in accord with the prodigious fecundity of Nature.

Then, how shall we account for the many kinds of vegetable forms? the ash, the oak, the beech, the elm, the pine, the birch? Are they evolutions from each other, or from imaginary trees of a long past epoch of earth-history?

But my main object is man. How came he? whence? and in what shape? Settle that, and all is settled. Darwinism tells us he is a lower animal, moulded by time and environments into his present form. The popular chant, "The long-tailed ape was the primal shape that led up to Adam and Eve," is not exactly an expression of Mr. Darwin's notion, though it is of Monboddo's. But Mr. Darwin might just as well have assigned us to an ape origin, as to a featureless thing of his own prolific imagination.

The origin of man has not been reasoned to. We cannot go back to it, fact by fact, for the needed facts are not. From first to last, we run through conjectures, and arrive at nothing but a final conjecture, worth no more than the conjectures that preceded it.

Whether the Caucasian man and the negro man have the same origin, is a problem standing from the general question for separate solution. Following the germ theory I have hinted at, would the germ from which the Caucasian would issue be one and the same, chemically, with that from which the negro would issue? But hinging on this is another question, Did the men appear contemporaneously?

Here, however, I must stop without completing my design. I have, I fear, already overrun the space I should have confined myself to.—Yours faithfully, B. Donbavand.

Picton, Chester.

Queries.

[143]—Gravity.—Does the orthodox definition of mass in terms of gravity $g\ M = W$ mean that it requires $\frac{1}{32}$ part of the weight of a body to overcome its inertia?—Zares. [It is a numerical statement, not a definition.—Ed.]

[144]—Mass.—If a weight, say one ton, be suspended by a perfectly flexible line of infinite length, what force in pounds would overcome the inertia of the mass in a direction at right angles to the direction of gravity?—Zares. [Any force, however small.—Ed.]

[145]—Inertia.—How is it that when I make 10,000 gallons of water pass over a perforated plate per minute, in a level position, there is a loss of 20 gallons per minute, but when the velocity of the water is reduced so that only 5,000 gallons per minute pass over, that then there is a loss of 250 gallons per minute through the perforations?—N.B.—50 per cent. of the plate has been punched.—Zares.

[146]—Chemical.—(1.) Why is the nitrogen contained in admixture with the oxygen in atmospheric air not absorbed by the lungs, as is the oxygen? (2.) If—as stated by Dr. Pavy and others—the value of hydrates of carbon as food is to be estimated *only* by the amount of unoxidised material they contain, what is the part played in the living body by the portion of the food already oxidised? Starch and sugar, *e.g.*, contain about 49 per cent. of carbon and hydrogen, and 51 per cent. of oxygen; so that but a very small amount of carbon remains unoxidised and available for combustion in the organism. What becomes of the bulk of such food?—E. M.

[147]—B. Sc. Examination, Edinburgh University.—I am desirous of obtaining information regarding the degree of B. Sc. at the Edinburgh University Examination. Would any of our correspondents kindly inform me through the medium of Knowledge what the subjects of examination are, and if it would be possible to pass without attending the University? If not, how long would I possibly have to attend, and what would be the probable costs for fees, books, &c.? I have attended evening classes in connection with the "Science and Art Department," and have passed first class in the elementary and advanced stages of chemistry (theoretical and practical), electricity, and acoustics, light and heat. Would the passing of these examinations be of any assistance? I have also an elementary knowledge of geology, botany, zoology, theoretical mechanics, and mathematics. An answer to the above will greatly oblige—A Philosophical Brushmaker.

[148]—Brewing.—(1). Having been in the habit of separating dextrose from cane-sugar by dissolving out the former in common alcohol, and having read in Prof. Graham's "Chemistry of Breadmaking," that dextrose is *less* soluble in alcohol than cane-sugar, I am anxious to ascertain which sugar is the more soluble in the said reagent. (2.) Does basic acetate of lead precipitate dextrin? All text-books I have read state so, and yet I cannot obtain a precipitate on adding small or large quantities of the said salt of lead to either dilute or concentrated solutions of dextrin.—E. M. D.

[149]—Diameter of Sun.—As we cannot see the half of a globe whose diameter is greater than the width of our eyes how much larger is the real diameter of the sun than the diameter we see? As I have not seen this taken into account in any book I have read, an answer would oblige, yours truly.—A. B. J. [The ratio of real diameter to apparent is that of tangent to sine of apparent angular radius, or, say, of 16 minutes. The logarithm of this ratio is 0·0000047, the number corresponding to which is about 1·000001; so that the sun's real exceeds his apparent diameter by about one-millionth part, or rather less than a mile.—Ed.]

[150]—Alpha Cassiopeia.—Can you tell me what is the magnitude of the companion of Alpha Cassiopeia?—Harris. [Estimated as about eleventh magnitude—bluish in colour.—Ed.]

[151]—Jordan Barometer.—What is the density of the glycerine in this, as used in the *Times* office? I make it 1·262 by calculation. Is this pure glycerine?—C. T. B.

[152]—Nickel-plating.—How is this done on iron without a battery?—C. T. B.

[159]—Cessation of the Sun's Heat.—It was stated by Sir J. Lubbock, at the last British Association meeting, that, after the lapse of seventeen million years, the sun would be cooled down to such an extent as to cease to emit light and heat. Will you kindly inform me on what grounds this is ascertained, and, if true, what must be the ultimate condition of the solar system, especially that of our own globe?—A. von Roulte.

[153]—Doubtful Organisms.—Kindly give me the names of those organisms, the nature of which, whether plant or animal, is doubtful.—H. J. C. W.—[Are any organisms doubtful, according to the modern definitions of plants and animals?—Ed.]

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[154]—FROGS.—Why are frogs excluded from the class Reptilia? —H. J. C. W.—[We always supposed that the class Reptilia included the Amphilia, and that frogs were classed as Batrachian Amphibia.—ED.]

[155]—TORTOISES.—What is the average duration of life of the tortoise, and how long can they remain under the earth?—H. J. C. W.

[156]—WORMS.—How is it that when a worm is severed in two, its parts still show signs of activity?—H. J. C. W.—[If you consider the nature of the nervous system in worms (and all articulated animals) that a double chain of ganglia, one may almost say of brains, runs along the body, you will see that the phenomenon is natural enough.—ED.]

[157]—ALUMINUM.—The characteristic ingredient of common clay—what is the present process of obtaining this metal, or is there a treatise published on its extraction? Will any one of the metallurgists of KNOWLEDGE kindly furnish the information to one who believes that (by a new process) the price of aluminum might be reduced to that of copper?—LUNA.

[158]—A 1 lb. weight is carried to the top of a tower. Would this, if allowed to fall, raise another 1 lb. from the ground? They are connected by a thread passing over a pulley. Neglect, of course, the weight of thread, and assume it to be perfectly flexible and to move without friction.—H. ROLFE.—["H. Rolfe" should read a description of Atwood's machine. The weights would not move unless some impulse were communicated to one or other. Such an impulse downwards on the upper weight would cause uniform motion of both weights, until the one which had been uppermost reached the ground.—ED.]

[160]—BOTANY.—Can any one tell me who was the author of "The British Garden," a descriptive catalogue of hardy plants, indigenous or cultivated, in Great Britain, with Latin and English names? Two vols., published by S. Hazard, of Bath, 1799.—EUPTERIS.

[161]—HEAT FROM THE STARS.—Does the earth receive an appreciable, or any amount of heat from the stars?—STUDENT. [From measurements of the heat of a few bright stars and comparison with heat received from sun, as also of light of star with light from sun, the inference seems sound that the total heat received from stars, bears to solar heat something like the same proportion that the light received from all the stars bears to the sun's light.—ED.]

Replies to Queries.

[79]—MENTAL PHYSIOLOGY.—As "S. S. S. S." seems anxious to test the accuracy of my information concerning Mr. Cyples's book, I can only tell him how it came under my notice, which was by press reviews, particularly one from Prof. Croom Robertson's organ, *Mind*, which carried conviction to my mind that a very unique and able work on the subject was referred to. I at once obtained it, and (as stated before) on the *mental* side, and as being exactly in keeping with its title, have never had any regret in so having purchased it. It would be out of place here to say further. If he went to Strahan's and asked to see the book, he might get a little idea thus of its character, &c.—S.

[125].—It *is* possible to prepare indigo on the large scale, but, unfortunately, *not* profitably. The well-known German chemical factory at Baden succeeded in producing artificial indigo, which made its appearance in the market as a commercial article, but it was announced in the newspapers a week or two ago that operations have been discontinued, as at present it cannot be made to pay.—H. GRIMSHAW.

[136]—SUNLIGHT ON FIRE.—The draught of a fire depends in great measure on difference of temperature between air in chimney and air in room. Sunlight, by heating the air round a fire, tends to create a draught in wrong direction. A smoker's draught, being created by the lungs, does not seem a parallel case.—C. T. B.

[71]—NAMES OF FLOWERS.—Hayward's "Botanist's Pocket-Book," 4s. 6d. (Bell & Sons), gives both scientific and common names, with concise characteristics. Dr. Hooker's "Student's Flora," 10s. 6d. (Macmillan), though giving fuller particulars than any other handbook, contains comparatively few common names. Bentham's "British Flora," 12s. (Reeve & Co.), contains many common names and a complete "English scientific nomenclature," also outlines of botany, &c.; but it includes fewer species and varieties than either Hayward's or Hooker's.—EUPTERIS.

[80]—THE CHIN.—"Ethnologist's" observations are not in accordance with the remarks of Lavater, who says that "flatness of chin bespeaks the cold and dry; smallness, fear; and roundness, with a dimple, benevolence." Elsewhere, he adds:—"A long, broad, thick chin—I speak of the bony chin—is only found in rude, harsh, proud, and violent persons.—EUPTERIS.

[90]—THE MAGNETIC NEEDLE.—I believe it is considered that a current of electricity is constantly passing round the earth from east to west, causing the magnetic needle to point north and south. Similarly, a wire from a battery, passing over or under the needle, will make it stand at right angles to the current.—EUPTERIS.

[105]—"J. S." can obtain all the information he requires from Mr. James English, naturalist, of Epping village, who is to be congratulated as the discoverer of a very ingenious, and, I believe, the only sure process of preserving fungi and lichens, and not only these, for in his hands even flowers of the most delicate structure and hue retain all the grace of form and richness of colour provided by nature. Having myself seen many remarkably perfect and beautiful examples of Mr. English's work on both fungi and flowers, I can recommend (as it gives me much pleasure to do) your correspondent and others interested in this really valuable discovery to communicate with him. In consequence of the great success of the method, and the large demand following upon it, I understand Mr. English is engaged upon publishing it in full—a generous act for the benefit of the world at large—and the subscription-list is open to any wishing to obtain a copy of his book. It only remains for me to add that, personally, I am entirely disinterested in the production, and offer this information as well for the profit of those botanists who are as yet unacquainted with this somewhat obscure but worthy worker, as for his own reward, and knowing that every nature-loving student will be glad to learn that the longed-for end has at last been secured, and that he can, without difficulty or expense, avail himself of its accomplishment. It may also be here recorded that it was the same industrious and deserving naturalist to whom we are indebted for introducing the largely-adopted practice of "sugaring" for moths.—W. W., Highbury.

[105]—FUNGI AND LICHENS.—In answer to "J. S.," in last Friday's KNOWLEDGE, Mr. D. Bogue, publisher, 3, St. Martin's-place, Trafalgar-square, publishes a book on British Fungi, by M. C. Cook, M.A., LL.D., which is, I believe, generally considered to be an excellent work.

[108]—THE EYE AS ONE OF THE SENSES.—In answer to "T. T." (query No. 128), the same publisher advertises a little book by Dr. Dudgeon, entitled, "The Human Eye: its Optical Construction popularly explained." Price 3s. 6d.—R. T.

[110]—THE COAL AGE AND THE EARTH'S INTERNAL HEAT.—The fact that in the lower levels of the silver mines on the "Cornstock" lode in Nevada (say 1,600 feet from the croppings), the men can only work fifteen-minute shifts, owing to the heat, may throw some light on this subject.—E. F. B. HARSTON.

[110]—THE COAL AGE AND THE EARTH'S INTERNAL HEAT.—The theory that the earth was once in a state of fusion, has many sound arguments in its favour, one being that the oblate-spheroidal shape of the earth was produced by the exertion of the centrifugal force on the molten mass of the earth, like a similar shape would be produced if a mop were whirled rapidly round in the hand. We have the evidence of geysers and hot springs, and, to some extent, of volcanos and earthquakes, that some of the original fire in the earth's internal regions still exists. The increase of temperature as we descend into the earth is 1° F., for every 50 or 60 ft. The gigantic flora of the coal period was perhaps as dependent on the internal as on the external heat which was exerted on it; that is, supposing, as most likely was the case, that the regions of fire in the earth were, in those remote ages of time, much greater than now,—each age witnessing a decreased space of internal heat compared with the preceding.—HERBERT R. WELLER.—[The answer is rather crude, but some of the relations indicated are worth studying.—ED.]

[131]—CREATION.—Read also Lyell's "Antiquity of Man" and Lubbock's "Pre-historic Times."—PAUGUL.

[133].—THE *Wesleyan Methodist Magazine* for science article every month, *Good Words*, of coming year, for articles on "Science and Religion"; also "Proceedings of the Royal Society," for a year or so ago, contain—or will contain—articles by the Rev. W. H. Dallinger. None of Mr. Dallinger's lectures have been published, I believe.—PAUGUL.

[134]—CHEAP TELESCOPE.—Complete instructions to make a telescope would, I fear, be too voluminous for this journal, requiring, as it would, a page or two; but if the querist will write to me I will give him the information he wishes for.—PAUGUL.

[136]—SUNLIGHT ON FIRES.—It is useless to quote housemaids about such things. It is absurd to suppose that sunlight prevents a fire or a cigar from burning. The fire will appear to be out when a bright light shines on it, and you *let* it go out when the sun shines, because it is warmer then than at other times. The fire in my study is in sunlight every day (if the sun appears), and sunlight has never yet put it out. I can also testify that in India the sun never puts out either fire or cigar.—PAUGUL.

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[141]—Time of Glacial Epoch.—This querist need not trouble himself about any other theories than Croll's. There are others, however, and if he is ambitious of wasting some valuable time he may read Col. Drayson's "Last Glacial Epoch."—Paugul.

Names of Stars.—In reference to letter 127, page 143, there is no work in English on the names of the stars. There is one in German, by a writer named Ideler, and is called "Ueber den Ursprung und die Bedeutung der Sternnamen"—"On the Origin and Signification of Starnames." It is a pity that there is no translation of this work into English. Of the great interest scientific, archæological, and poetic, attaching to the names of stars, there surely can be no question.—Zeta.

Weather Guide.—(Page 128). Allow me to mention that Messrs. Routledge publish just such a guide, entitled "A Manual of Weathercasts," 1s.—Eupteris.

Answers to Correspondents.

*** All communications for the Editor requiring early attention should reach the Office on or before the Saturday preceding the current issue of* Knowledge, *the increasing circulation of which compels us to go to press early in the week.*

Hints to Correspondents.—1. *No questions asking for scientific information can be answered through the post.* 2. *Letters sent to the Editor for correspondents cannot be forwarded; nor can the names or addresses of correspondents be given in answer to private inquiries.* 3. *No queries or replies savouring of the nature of advertisements can be inserted.* 4. *Letters, queries, and replies are inserted, unless contrary to Rule* 3, *free of charge.* 5. *Correspondents should write on one side only of the paper, and put drawings on a separate leaf.* 6. *Each letter, query, or reply should have a title, and in replying to letters or queries, reference should be made to the number of letter or query, the page on which it appears, and its title.*

Kay. Your suggestion, that ladies should meet for discussion of matters scientific, educational, phrenological, and physiological, instead of tea and small talk, is no doubt excellent; but our space is too crowded for the insertion of your remarks in full.—Zares. We agree with you that all paradoxes should not be omitted from a paper like the present. We propose to act in accordance with that view.—T. Preston Battersbye. From some of my published essays, you will see I take great interest in the phenomena of mesmerism: I would like much to see your papers.—W. A. C. What we said about vivisection was very moderate. We, of course, have nothing to say to the change of law, which you suggest as logical. If you had ever known the torture of one dear to you alleviated through knowledge acquired from such experiments as you denounce, you would possibly see that the question has two sides to it.—One Interested in Science. Heat waves and light waves are of the same nature, and both travel through the ether. Many light waves are heat waves, and *vice versâ*. Your second question belongs to a region outside of knowledge. The gratings referred to by Prof. C. A. Young, are what are called refraction gratings, in reality, series of fine parallel lines cut on glass very close together. The formation of a spectrum by means of such a grating requires a fuller explanation than we can give here. A collimator is a portion of the spectroscopic apparatus by which the rays are made parallel before entering the spectroscope proper.—Gun. The dimensions of space may be described as length, breadth, and depth. In a plane we have only two dimensions, length and breadth. Some geometers think they can imagine the possibility of a fourth dimension. When they can show us that a point may be neither in a plane nor out of it, we may begin to think with them.—W. Wilson, M.A. Is it not purely a question of words? You would say, we see the light that comes from an object; others would say (and, I think, rather more correctly) that we see the object by means of the light.—Henry Wentworth Monk. You suppose I "have not forgotten publishing" for you "in the *English Mechanic* about nine years ago;" I remember writing a short notice in the Paradox Column of your theory of Re-Creation, but "publishing" for you would have been a different matter. I have read your letters headed "The God of Israel" and "The Lord of Hosts" in the *Jewish World*. Thanks for sending the paper to me; but the letters are hardly suited for notice in these columns.—F. P. No; at least that was not the name given. Sleep preventatives are not safe. Drowsiness (unless following after too heavy a meal, the use of stimulants, opiates, and the like), means that rest is needed, and that, therefore, rest should be taken. Your other query would hardly be understood. Even Dr. Andrew Wilson could not, off-hand, tell you the name, origin, and habits of creatures about which you only say that they are minute, have developed themselves recently within your aquarium, are white, have numerous legs, and dart through the water with a jerky, spasmodic movement, some of them carrying what you suppose to be their young upon their backs. But if you were to describe briefly the original contents of your aquarium, give the exact number of legs, and state something definite as to the size and shape of the small white creatures, your query should appear.—Harry Whates. We should have to insert rejoinders if your article were published. We have definitely stated more than once that our subject is science, and that in these pages the religious doctrines of no sect whatever shall be either attacked or defended.—E. Burke. Declined with thanks; no space.—R. T. Thanks; but we ought not to insert what amounts in fact to a definite advertisement of the books named. Cause of curved shape of rainbow has been explained in recent numbers. Along lines inclined at a certain angle to the line from sun to observer (they make an acute angle with this line produced) come the rays giving, after internal reflexion in rain drops, each particular colour. Therefore, the rainbow arc of that colour is a circle on the sky, having the point directly opposite the sun (with reference to the observer) as its centre. Loomis's "Treatise on Practical Astronomy" is, we believe, to be obtained of Trübner, if not published by them. Its price is 8s. or 8s. 6d. —W. B. Russell. The promised paper on the subject of moon's former proximity to the earth shall presently appear. (The moon was not projected from the earth, according either to this theory or to any other regarded as admissible by science.) No. 7 can still be obtained from the publishers.—Toper. Your question is vague. You can get a useful knowledge of the elements of astronomy with the time you mention as at your disposal, if you use it well. But the books you have are not very well suited for your purpose. Herschel is too difficult, and the "Elementary Lessons" (though written by one who has done excellent work in some departments of astronomy) has too many errors in it to be of much use, unless, indeed, you could get from Appleton's, New York, the American edition, in which the errors arising from the author's want of familiarity with mathematical and theoretical astronomy have been corrected. —Excelsior. We thoroughly agree with you, though we have no room for your letter. Whipping means, in ninety-nine cases out of a hundred, laziness and bad temper on the teacher's part; where the teacher is also a parent, you may say a hundred instead of ninety-nine.—Amicus Scientiæ. We have already reprinted back numbers, but third editions are rather costly affairs.—M. J. H. As a rule, extra outlay for larger size telescope will repay. Few ever buy a telescope who do not before long wish they had bought a larger one. I would advise you to get the largest and best you can afford. Such an instrument as you describe would do a great deal of interesting work for you, if the object-glass is by a good maker. The question about nebulæ and double stars is vague. Every telescope will show some double stars, and give interesting views of some nebulæ. See answer to "Amicus Scientiæ" as to back numbers.—J. C. Lloyd. The constellations revolve around the pole, the pole itself remaining unchanged in position. The pole-star revolves in a small circle around the pole.—M. M., *alias* J. H. Have we not requested that you would put outside your letters an address to which they may be returned? Did you think we were blind, that we should not see through so thin a disguise? —W. Scott. Mr. Allen shows that where such and such qualities appear, such and such results follow. If the results you suggest followed from the silveriness of whitebait, natural selection would cause the species to become less silvery, generation after generation. But doubtless the colour is protective. In what you suggest as to creatures animate or inanimate having anything to do with the matter, of their own will, you are, of course, joking.—William Fredericks. Is there a bump of spelling in your phrenological system? Or are we to suppose that the "prooff" and "infamation" you require are some articles of which we have not yet heard? We have not asserted that "to term a system a science it must have adherents among men of science," because that needs no assertion, and requires no proof. To be scientific, a system must be able to bear scientific tests.—J. Baretz. You say, amongst other remarkable things, that the celebrated Courvoisier was a great admirer of Gall and Spurzheim: surely you must mean Corvisart. Courvoisier was a murderer.—W.B.G. You are right, but the fact is pretty well known that Archimedes showed the sphere and circumscribing cylinder to have equal curved areas, as a preliminary to establishing the relation between their volumes. It has never yet been shown that the π relation in the great pyramid should replace that given by Herodotus as the one determining the pyramid's height—namely, that surface of each face is equal to square on diameter. The pyramid fulfils this quite as closely as the other.—Cosmos. We sympathise with your views; but we have to combine several qualities in order to appeal to as many as possible.—W. Cave T. Longmans, Chatto & Windus, and Smith, Elder, & Co.—S. E. O'Dell. No, sir. We are obliged to you, but desire no continued articles in favour of phrenology, or against t

either.—ZARES. When did we promise to insert authentic abnormal mental phenomena? We promised to insert accounts of scientific experiments relating to mental matters. The story you relate, "told you by a reliable person," can hardly be so described. It is, in fact, one of those which we considered likely to reach us too freely if we opened the columns of KNOWLEDGE to accounts of spiritual manifestations.—H. WOOLLEY. We are inclined to agree with you, perhaps because it would save us much trouble to exclude such letters as you refer to.—AMOS HINTON. Because fresh cold air continually replaces that which had been in contact with the body, which in a calm would be warmed.—A CROSSLEY. The nebular hypothesis of Laplace is seldom correctly explained. An interesting account of it is given in Nichol's "Architecture of the Heavens."—G. H. MAPLETON. Printing the star-maps on a separate loose sheet involves extra expense, and this is a rather important consideration in a journal so cheap as ours.—A. T. C. Absolutely impossible to find room for your solar puzzle. But it is certain that if you had got up while the phenomena were in progress, and looked through the holes, at the sun, you would have seen some object, near or far off, obscuring his disc.—OSWALD DAWSON. You require our correspondents to be somewhat too precise. They know what they mean, pretty well, when they speak of the relative position of the sexes (to take one of your examples); why insist that they should define when, where, and how, in precise detail, they mean the sexes to be compared.—A correspondent, who gives us no name, asks us to explain the electro-magnetic theory of light. We know of no such theory. The writer who says the undulatory theory is fast being swallowed up piecemeal by the electro-magnetic knows very little about the matter. The evidence for the undulatory theory is simply overwhelming.—W. E. BLYTHE. Thanks for abstracts, which shall appear.—FRED. DENIER, Milwaukee. Thanks for encouraging words.—HARRIS, J. J. BRUM, and J. P. GILMOUR. Thanks; one sees the silver side, the other the golden: but it is the same shield.—J. CALVERT. Your advice to the eminent professor, coupled with that which you are good enough to give us, brings to the mind, somehow, the instructive lines:—

> Teach not a parent's parent to extract
> The embryo juices of an egg by suction;
> The good old lady can the feat enact
> Quite irrespective of your kind instruction.

A. J. MAAS notes that he receives KNOWLEDGE regularly every Sunday in Switzerland, so that booksellers who supply it in England on Tuesday or Wednesday might presumably do better. —EDWIN WOOTON. Fear we cannot in any way advance your scheme. Personally we are not in love with the society system of science work. Most scientific societies seem, somehow, to act as nurseries of disputes and difficulties.—RAVEN. Whether the account you refer to is reconcilable or not with the theory of evolution is a question not open for discussion in these columns. The account, whether right or wrong, is extra-scientific.—F. S. C. Your original polygon was an octagon. The polygon which your later communication requires could be readily drawn if any angle could be trisected, otherwise not. Consider the trouble taken by Euclid in Book IV. to show how polygons whose sides subtend particular angles may be described, and you will see that we cannot give as part of a solution such a direction as this: "The apex of angle being at centre of circle, inscribe a polygon which shall have three of its sides between sides of angle, commencing the polygon at one of the sides," without showing first how this is to be done. Your other communications thankfully received.—H. C. (i.) The accepted theory of light is that it arises from an undulatory motion in an ethereal medium occupying all space. (ii.) Cold water is heavier than warm. (iii.) We have heard of no new theory respecting the formation of the coal-measures. (iv.) I.H.S. stands for *Jesus hominum salvator*.—PHILADELPHUS. The writer of the article in question in no sense infringed our rule. He puts it as a scientific view that faith in dreams as supernatural visitations is one among many survivals of rude primitive philosophies. He indicates also pretty clearly his own belief that the phenomena of dreams are all readily interpretable without any appeal to the supernatural. This is unquestionably the attitude of science in the matter. I, at any rate, should be very much surprised to hear that any man of science viewed the matter differently. Well, now, you quote certain statements which do not seem reconcilable with these views. But science has nothing whatever to do with those statements. They are entirely extra-scientific. You might as well quote other statements, found in company with those you mention, to show that an account here of scientific views respecting floatation must be regarded as a breach of our rule that dogmatic religion should not be attacked in these columns. Or a Brahmin might as reasonably object to the views about distracted attention under head, "Mind Troubles," that they seem to him inconsistent with correct views about the Nirvana. Can you not see that the supernatural has no place in arguments relating to the natural? As to the inconsistency you indicate, we may or may not, Mr. Clodd might or might not, agree with you. What can it matter one way or another, when we positively decline to have such questions discussed here? In reply to your other question, Whitaker's Almanack decidedly overrates the prolificness of Bradford folk. It should be not 83·1 but 38·1 per thousand.—F. STANLEY. Newton's estimate of terrestrial compression was based on an incorrect hypothesis as to density at different levels below the surface. Joyce is not an authority, any way. The true compression is about 1-300th, or polar radius about 13¼ miles less than equatorial.—A. J. MARTIN. Rightly understood, what we said was an answer to your question. The focal image of a planet is examined by the eye-piece (which is really a microscope), and cannot be examined with an eye-piece of more than a certain power, because its imperfections are such—no matter how excellent the object-glass—as to preclude more than a certain degree of magnifying. By receiving the image on a screen, even were the screen perfect, we do not diminish its imperfections, and we lose light. Therefore, we cannot use a microscope in the ordinary way with any advantage. In fact, if an eye-piece is used to throw the rays on the screen, the image so formed can be best magnified by simply increasing the screen's distance from the eye-piece. We are then magnifying without any of the optical disadvantages which would result from using a microscope. But we find no increase of distinctness in this way after a certain convenient distance has been reached—only loss of light and such increase of all imperfections that the image becomes confused and indistinct.—PAUGUL. Thanks; but at present no space.—EXCELSIOR. If you only knew how much labour we should save by doing what you ask! But then many would say it was pure selfishness.

Notes on Art and Science.

A NEW VARIETY OF GLASS.—A Vienna chemist has recently discovered a new variety of glass. It does not contain any silica, boric acid, potash, soda, lime, or lead, and is likely to attract the attention of all professional persons on account of its peculiar composition. Externally it is exactly similar to glass, but its lustre is higher and it has a greater refraction, of equal hardness, perfectly white, clear, transparent, can be ground and polished, completely insoluble in water, neutral, and it is only attacked by hydrochloric or nitric acid, and is not affected by hydrofluoric acid. It is easily fusible in the flame of a candle, and can be made of any colour. Its most important property is that it can be readily fused on to zinc, brass, and iron. Is can also be used for the glazing of articles of glass and porcelain. As hydrofluoric acid has no effect on the new glass, it is likely to find employment for many technical purposes.—*Wiener Gewerbe Zeitung*.

AN ELECTRIC BUOY.—A daily contemporary states that experiments are being made in the Lower Bay, New York, with a new electric buoy, the invention of Mr. Bigler, of Newburg. Mr. Bigler, it appears, owns the patent of the old Courtney Whistle Buoy, the principle of which he combines with an intermittent light, the same power which blows the whistle being used to generate the electricity that furnishes the light. The rise and fall of the waves compresses the air inside the buoy. When this pressure has reached a certain point, it works a dynamo machine and burner furnished by the Edison Electric Light Company. This machine is supposed to generate enough electricity to show an intermittent light. When the pressure is exhausted by the action of the machine, which makes about 300 revolutions per minute, the light goes out until the pressure is renewed by the motion of the waves. The more violent the waves the more powerful the light, up to a certain point. Thus the light is at its brightest during a hurricane.—*Scientific American*.

THE WINTER FLIGHT OF THE SWALLOWS.—The swallow is one of the best known, and, therefore, most interesting, of migratory birds. Excepting when kept in confinement, this bird knows neither the extreme of hot nor cold weather. As soon as the cold weather approaches, he migrates with his family to a warmer climate, and again to the northward when the temperature of its second home becomes inconvenient to its sensitive existence. In England, as a general fact, the swallow does not arrive until the second week in April, and takes his departure about the middle of September. Before the time of their flight, they assemble in vast numbers in a comfortable locality, and are seen chattering very eagerly, as if holding a huge convention for the settlement of affairs before starting on their long journey. Although starting off

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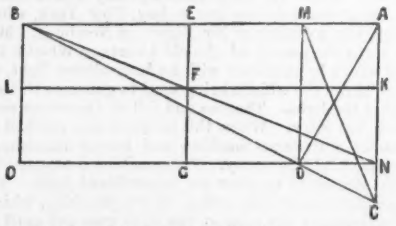
together, they do not remain so, preferring to separate into innumerable groups, like families or tribes, and sometimes making the long transit in companies of two, three, or five. While remarkable for the power and speed of their flight, they become fatigued in passing the sea, and will flock in great numbers upon the rigging of a ship passing their course for a rest. Sometimes the birds are so utterly worn out with fatigue, that when they have perched upon the side of a boat they are unable to take again to the wing, and, if disturbed, can scarcely fly from one end of the boat to the other. They have even been seen to settle upon the surface of the waves, and to lie with outspread wings until they were able to resume their journey. Guided by some wonderful instinct, the swallow always finds its way back to the nest which it had made, or in which it had been reared, as has frequently been proved by affixing certain marks to individual birds and watching for their return. Sometimes it happens that the house on which they had built has been taken down during their "season abroad," and in that case they exhibit a most pitiable distress, flying to and fro over the spot in vain search after their familiar domiciles, and filling the air with a mournful cry, announce to their friends that they have been dispossessed or evicted in the interest of local improvements. The swallow is widely spread over various parts of the world, being familiarly known throughout the whole of Europe, not excepting Norway and Sweden, and the northern portions of the continent.—*Frank Leslie's Magazine.*

Our Mathematical Column.

MATHEMATICAL QUERIES.

[14]—Can you inform me—(1.) Whether the axis of any cone passes through one of the *foci* of every ellipse formed by a section of that cone? (2.) Whether the two ellipses formed by the section of the two cones having a common apex and a common axis, by the same plane passing through both, at any angle to the common axis, are of similar eccentricity? (3.) Whether or not the angle of inclination of the ecliptic to the axis of rotation of the sun bears the same relation to the eccentricity of the earth's orbit, as the angle which the plane of any ellipse forms with the axis of its cone bears to the eccentricity of such ellipse?—No Mathematician.—[None of these relations hold. The simplest way to determine the foci is this:—Take a plane through axis of cone and at right angles to the cutting plane. A circle inscribed in the triangle in which the plane cuts cone and cutting plane will touch the axis of ellipse in one focus. The escribed circle touches it in the other.—Ed.]

"T. R." sends an ingenious solution of No. 7, p. 148 (Knowledge, No. 7), in which he claims (erroneously) that no proposition beyond those in Euclid Book II. is employed. We have slightly modified the construction in what follows, in order that the figure may be more conveniently shaped, but the solution is in effect the same that "T. R." has kindly sent us.



We have in right angled triangle *BAC*, *AD* perpendicular to hypothenuse, *DM*, *DN* perpendicular to *BA*, *AC*; and we have to show that angle *BMC*=angle *BNC*.

Rect. *BM*. *MA*=*MD*² (whereabouts in Books I. and II. is this proved? It might be given as a corollary from II., 14, but not without some proof bringing it within the range of Book III.). Hence, adding *MA*² to each, we have—

BA. *AM*=*AD*²=(similarly) *AC*. *AN*.

Complete rectangle *ANOB*, take *AK*=*AM*; draw *KL* parallel to *AB*, cutting *BN* in *F*; and draw *EFG* parallel to *AN*. Then rect. *EO*=rect. *AL* (*FA* and *FO* being complementary)=*BA*. *AK*=*CA*. *AN*. Hence *BE* must be equal to *AC*; and *EF*=*MA*. Hence triangle *BEF* is equal in all respects to triangle *CAM*. Thus angle *ACM* (=alt. angle *CMD*)=angle *EBF*=alt. angle *BNO*. Adding a right angle to the equal angles *CMD* and *BNO*, we have angle *BMC*=angle *BNC*.—*QED*. The proof is not so easy as either of those we gave, but it illustrates a useful method.—Ed.

W. Ridd obtains a result, in examining the problem dealt with in query 92, p. 145, slightly different from ours. We gave for the eastwardly deflection of a projectile let fall from a height h, $\frac{2\pi ht}{P}\cos\lambda$ where t is the time of the fall, λ the latitude, and P the earth's rotation-period. He gets instead $\frac{2\pi(r+h)t}{P}\cos\lambda$ Mr. Ridd overlooks the circumstance that the point below moves eastward at such a rate as to be carried a distance $\frac{2\pi rt\cos\lambda}{P}$ eastward in time t, so that the actual eastwardly deflection is only the difference of these, or $\frac{2\pi ht\cos\lambda}{P}$. The result is not slightly, but very, different from that we gave, being more than $\frac{r}{h}$ times as great, so that if h be 88 yards, W. Ridd's result would be greater than mine in the same degree that the earth's radius, or about 3,960 miles, exceeds 88 yards, or 3,960 × 20 times, or 79,200 times! In fact, Mr. Ridd's error is the converse of Tycho Brahe's, who, in a letter to Rothmann, asked, "how it was possible that a ball dropped from the summit of a tower should always fall close to the foot of it, since the tower must have moved a considerable distance towards the east while the ball was falling; if the height of the tower were 400 feet, the falling body should strike the ground 1¼ miles westward from the foot of the tower, which is contrary to all observation."

But, as a matter of fact, the result we gave is only correct when we neglect the circumstance that during the fall the direction of gravity on the falling body varies, so that—first, the direction of the body's excess of eastwardly motion over the eastwardly motion of the point vertically below the point of suspension, is not always at right angles to the moving vertical, and, secondly, gravity acts during the fall to partly diminish this part of the motion. These may seem very unimportant matters, but, as a matter of fact, when they are taken into account, the calculated eastwardly deflection is found to be diminished from $\frac{2\pi ht\cos\lambda}{P}$ to $\frac{4\pi ht\cos\lambda}{3P}$.

We leave it as an exercise to the student to obtain this result by analytical methods. (If any difficulty should be found, we shall be glad to give the solution.) The following geometrical method will be readily understood by a larger number:—

Let A be the point of suspension, B the point vertically below it, C the earth's centre, BEF the earth's surface along a great circle through BA, and touching the latitude-parallel (or small circle) through B, so that BF may be regarded as part of this latitude-parallel. The body falling from A, with such eastwardly motion as belongs to the point of suspension A, travels in an elongated ellipse, AFA', having C, the earth's centre, as a focus, and reaches the ground at F, the arc APF being appreciably parabolic. Suppose that while this descent is taking place the point of suspension, A, is carried by the earth's rotation to D, and join DC and FC, DC cutting BF in E, and APF in P. Also let arc AD produced meet CF produced in G.

Then, since the point of suspension A, and the falling body when just leaving A, are sweeping out equal areas around C, and continue to sweep out areas uniformly during their motion (the former because of the uniform rotation of the earth, the latter by Kepler's second law), it follows that

Area ACD=area $APFC$.

Whence, taking away from each the area APC

Area APD=area CPF.

Whence approximately (since PE and EF are each very small, compared with AB, BF, &c.)

Area AD=area CEF,

or, approximately, $\frac{1}{3}AB.BE=\frac{1}{2}EF.BC$.

Whence $EF=\frac{2}{3}\frac{AB.BE}{BC}$;

or, since $AB=h$, and $BE=2\pi r\cos\lambda.\left(\frac{t}{T}\right)$

the easterly deflection $EF=\frac{2}{3}.\frac{h}{r}.2\pi r\cos\lambda.\left(\frac{t}{P}\right)$

$=\frac{4\pi ht}{3P}\cos\lambda$

Our Whist Column.

BY "FIVE OF CLUBS."

THE LEAD.

THE customary way of treating leads at Whist is found perplexing by beginners. A number of suits are considered, and the proper lead from each is indicated, with perhaps the play second round; until the learner wonders how much he is expected to remember of what appears to him a perfectly heterogeneous collection of rules. Thus, take Captain Campbell Walker's very useful book, "The Correct Card." In this there are 36 cases of suits headed by an Ace, with the play for each; 18 cases of suits headed by King; 7 of suits headed by Queen; 9 of suits headed by Knave; 4 of suits headed by 10; and two of suits headed by a small card. In all, 76 cases are considered. The natural idea of the learner is that he ought to commit to memory all these 76 cases, with the exceptions noted in 19 notes, before he can lead properly; while, after that, he will have to learn an equally voluminous series of rules for play second hand, third hand, and fourth hand. He naturally despairs of accomplishing this without giving much more time to the matter than the game, good though it is, seems worth.

But even when the learner has committed all these rules to memory, he still finds that there is something—embodied, indeed, in them, but not obviously expressed by them—which it is absolutely essential that he should grasp. He requires to know not only what he should lead from a given suit, but what each lead means.

Now it does not seem to have been noticed by writers on Whist, that by beginning at this end they get rules much more easily remembered, because at once made practically available, and also much fewer in number. In point of fact, the rules which seem without system have a system at the back of them, and this system is at once displayed when we reverse the usual method of presenting the rules for leading, and begin by asking what particular leads may mean. Afterwards we may collect together a hundred or so of such rules and exceptions, as appear in Captain Walker's book, for then each rule will be easily remembered as a necessary inference from the principle on which the lead and the interpretation of the lead alike depend.

We begin then by considering, *not* the multitudinous leads from suits headed by an Ace, but from what suits containing an Ace, the Ace should be led. It will be seen that there are only a few cases in which Ace is led, and these easily remembered; and also that once we know when an Ace should be led, we know what the Ace lead means—

When, then, should an Ace be led?

From long suits, and from suits of not less than three, Ace is only led:—

(1) from Ace and four or more others (not including King).
(2) from Ace, Queen, Knave, with or without others.

From suits of two cards (which it can hardly ever be right to open—and never as an original lead), containing an Ace, Ace is always led.

From long suits, then, or suits of three, which only are in question in ninety-nine cases out of a hundred, there are only two cases to be considered. The play second round, supposing the Ace not trumped, will show from what sort of suit the Ace was led. For,

(1) If Ace is led from Ace, four or more, a small card is led second round.

(2) If Ace is led from Ace, Queen, Knave, and others, either the Queen or the Knave is played second round—the Queen, if the suit did not originally contain more than four cards, the Knave if it did.

Thus when your partner leads an Ace, you know at once that he has not the King. If you have the Queen or the Knave, you know he has not led from Ace, Queen, Knave, and therefore that he has four more cards in the suit.

If the lead is not an original lead, and the play has given reason to believe that your partner has been driven to a forced lead, the Ace may have been led from Ace and another. This can scarcely ever happen, but when it does happen the previous circumstances of the play and what follows the forced lead (together with the study of your own hand) will almost always show you that the lead has not been from strength.

In our next we shall consider *why* Ace is only led from long suits, under one or other of the circumstances stated above. We may note, indeed, in passing that on the Continent, Ace is led from Ace and three others (not including King), though the laws of probability point to the play as not the best. It is well to remember, however, when playing with Continental players, that this is the rule with them.

Our Chess Column.

TWO KNIGHTS' DEFENCE (*Continued.*)

IF White on his 8th move should play B. to Q.R.4., Black will soon obtain the better game, *e.g.*,

1. P. to K.4. / P. to K.4.	2. Kt. to K.B.3. / Kt. to Q.B.3.	3. B. to B.4. / Kt. to K.B.3.
4. Kt. to K.Kt.5. / P. to Q.4.	5. P. takes P. / Kt. to Q.R.4.	6. B. to Q.Kt.5.ch. / P. to Q.B.3.
7. P. takes P. / P. takes P.	8. B. to Q.R.4. / P. to K.R.3.	9. Kt. to K.B.3. / P to K.5.

In reply White has no satisfactory move, *e.g.*

10. Kt. to Kt. sq. / B. to Q.B.4., or	10. Kt. to K.5. / Q. to Q.5., or	10. Q. to K.2. / B. to K.3.
11. P. to Q.B.3. / Q. to Q.Kt.3., or(*a*)	11. B. takes P.ch. / Kt. takes B.	11. Kt. to K.5. / Q. to Q.5., or (*A*)
12. Q. to K.2. / B. to Q.R.3.	12. Kt. takes Kt. / Q. to Q.B.4., winning the Knight.	12. B. takes Q.B.P.ch. / Kt. takes B.
(*a*) 11. Kt. to K.2. / Kt. to K.Kt.5.		13. Kt. takes Kt. / Q. to Q.B.4.
12. Castles. / Q. to K.R.5. with a winning game.		14. Q. to Q.R.6. / B. to Q.sq.
		15. P. to Q.Kt.4. / Q. takes Q.B.P.
		16. Q. to Q.Kt.5. / Q. takes B.ch.
		17. K. to K.2. / Q. takes R. with a winning superiority.
(*A*) 11. Kt. to Kt.sq. / B. to Q.B.4.	12. P. to Q.B.3. / B. to Q.B.5.	13. Q. to Q.sq. / Q. to Q.Kt.3.

And Black has a fine game.

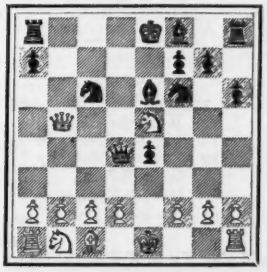
In this variation an interesting novelty has recently been discovered on White's 13th move, viz.,

1. P. K.4. / P. K.4.	2. Kt. K.B.3. / Kt. Q.B.3.	3. B. to Q.B.4. / Kt. to K.B.3.
4. Kt. to K.Kt.5. / P. to Q.4.	5. P. takes P. / Kt. to Q.R.4.	6. B. to Kt.5.ch. / P. to B.3.
7. P. takes P. / P. takes P.	8. B. to Q.R.4. / P. to K.R.3.	9. Kt. to K.B.3. / P to K.5.
10. Q. to K.2. / B. to K.3.	11. Kt. to K.5. / Q. to Q.5.	12. B. takes P.ch. / Kt. takes B.,

instead of the usual move 13. Kt. takes Kt., which, as we have shown, results to the advantage of Black. White can also play 13. Q. to Kt.5.,* out of which reply some interesting variations arise.

POSITION of 13. Q. to Kt.5.

BLACK.



WHITE.

Should Black now play the likely looking move of 13. ‡B. to Q.2., White would win by 14. Kt. takes Kt. / Q. to Q.3. 15. Q. to K.5.ch. remaining with two Pawns ahead. The proper reply to 13. Q. to Kt.5. is B. to Q.B.4.,† which we will examine. 14. Q. takes Kt.ch. / K. to K.2. White has now three moves at his disposal.

* Played at St. Petersburg, in a game between Prince Dadian, of Mingrelia, and M. Liselle.

† This defence was discovered by Signor Constantini, one of the strongest amateurs in Italy.

	1.	2.	3.
15.	Q. to Kt.7.ch.	Q. to B.7.ch.	Castles.
	K. to Q.3.	K. to B.sq.	Q. takes Kt.
16.	P. to K.B.4. or(a)	P. to Q.B.3. or(A)	P. to Q.3.
	P.takesP.*en.p*	Q. takes P.ch.	K. R. to Q.B.sq.
17.	Kt. takes P.	K. to Q.sq.	Q. to Q.R.4.
	Q. to B.7.ch.	R. to Q.B.sq.	Kt. to K.Kt.5.
18.	K. to Q.sq.	Q. to Kt.7.	P. to K.Kt.3.
	Q. takes Kt.P.	Q. to K.B.4.	P. to K.6.
19.	Q. to R.6.ch.	and wins.	and wins.
	K. to B.2.		
20.	Q. to K.B.sq.	(A)	
	B. to K.R.6.	16. Castles.	
21.	P. to Q.4.	R. to Q.B.sq.	
	Q. takes Q.	17. P. to Q.B.3.	
22.	R. takes Q.	Q. to Q.4.	
	B. takes R.	18. P. to Q.B.4.	
23.	P. takes B.	Q. to Q.5.	
	Q. R. to Q.sq.ch.	winning the Knight.	
24.	B. to Q.2.		
	K. R. to K.sq.		
25.	Kt. to Q.B.3.		
	Kt. to K.5.		
26.	Kt. takes Kt.		
	R. takes Kt.		
	Black wins.		

(a) 16.	Kt. takes B.P.ch.	Q. takes B.	K. to Q.sq.
	B. takes Kt.	Q. takes P.ch.	Q. takes Kt.P.
19.	R. to K.sq.	R. to K.2.	Q. to Q.Kt.7.
	Q. to Kt.5.ch.	K. R. to K.B.sq.	Kt. to Q.4.

and wins.

If White on his 8th move should play Q. to K.B.3., Black ought, likewise to obtain the better game, *e.g.*,

1.	P. to K.4.	2.	Kt. to K.B.3.	3.	B. to Q.B.4.
	P. to K.4.		Kt. to Q.B.3.		Kt. to K.B.3.
4.	Kt. to K.Kt.5.	5.	P. takes P.	6.	B. to Q.Kt.5.ch.
	P. to Q.4.		Kt. to Q.R.4.		P. to Q.B.3.

7. P. takes P. / P. takes P.

8. Q. to K.B.3.

In reply, Black has three moves, viz.,

8.		8.		8.	
	Q. to Q.B.2.		Q. to Q.Kt.3.,		P. takes B.
9.	B. to Q.R.4.	9.	B. to Q.R.4.	9.	Q. takes R.
	B. to Q.3.		B. to K.Kt.5.		B. to Q.B.4.
10.	P. to Q.3.	10.	Q. to K.Kt.3.	10.	Q. to K.B.3.
	Castles.		P. to K.R.3.		B. to Q.Kt.2.
11.	Castles.	11.	Kt. to K.B.3. or(A)	11.	Q. to K.Kt.3.
	P. to K.R.3.		B. to Q.3.		Castles.
12.	Kt. to K.4.	12.	P. to K.R.3.	12.	P. to Q.3.
	Kt. takes Kt.		Kt. to K.5.		P. to K.5.
	to be followed by	13.	Q. takes B.	13.	Castles.
	P. to K.B.4.,		Kt. takes K.B.P.		P to Q.Kt.5.
	with a good game.	14.	Q. takes P.	14.	B. to K.3.
			Kt. takes R.		B. takes B.
		15.	Q. takes R.ch.	15.	Q. takes B.
			K. to Q.2.,		Kt. to Q.4.
			winning the Queen as	16.	Q. to K.Kt.3.
			he threatens Mate by		P. takes P.
			Q. to B.7.ch.,		P. to Q.B.3.
			Q. to B.8.ch.,	17.	Q. to K.B.3., or
			and Kt. to B.7.ch.		to Q.Kt.3., and Black
					has a good game.

(A) If White should play Kt. to K.R.3., the following would ensue—

11.	Kt. to K.R.	12.	Castles.	13.	Kt. to Q.B.3.
	B to Q.3.		Castles. Q.R.		P. to K.5.
14.	Q. to K.3.	15.	Kt. takes P.	16.	K to R.sq.
	Q. to B.2.		B. takes P.ch.		K. R. to K.sq.,

and Black has the better game. Of course he could not play 11. Q. takes P.ch., for Black would reply with K. to Q.2., which would win, as he threatens R. to K.sq., and the white Knight is also *en prise*.

A. J. Maas. Thanks for end-game, which shall be analysed.—H. A. N., R. Kelly, S. K. L. L., and others. Problem No. 5 cannot be solved, as you suggest, by 1. R. to Q.Kt. 7. If Black take Kt. with B., there is no mate, or Black may play Kt. to R.'s 5th ch., taking B next move.—J. B. M. and S. K. L. L. In our note on problem 6, we should have said, "by adding a Black Knight at Q.'s sq., not Queen's 8th." Better consider, however, that a second solution is required, the position remaining unchanged.—D. See. If eight first moves are given as odds, none to be across the board, the receiver of the odds can make the game absolutely certain in a number of ways. We do not know that there is any way by which mate in a given small number of moves may be announced before Black plays a move. There may be, however.—H.A.L.S. Thanks. Your solutions of Nos. 7 and 8 correct, of course. The question was not as to the justice of rejecting No. 7, but of ignoring its author's statement, that, so far as he was concerned, it was original. As a part of the idea had been anticipated, there was a valid—though, we think, insufficient—reason for declining to insert. You admit that the editor's is superior in finish, &c., to D'Orville's. The idea is one which would be apt to suggest itself to a problem composer; but in D'Orville's problem the solution can hardly be escaped; in the editor's there are several promising lines of attack.—Jas. D. Meek. You are right. White could not draw; though, of course, he would not throw away his Rook by checking, as when Queen was made.

Curious Freak of a Dog.—Dr. Onderdonk sends the following story of a freak of a dog to the *Scientific American*:—"Simmons" (that is the dog's name) is very remarkable for her sagacity, and often excites remark by the "reasonableness" of her actions. She is a constant companion of the boys, and seems to consider herself one of them. She has been a mother three times; the third time some ten days or so ago. At her two former *accouchements* she did herself credit by the respectable size of the family she brought to light; but this last time she gave birth to but one pup. Two or three days before the birth of this pup there was a litter of kittens born on the place. Simmons, disgusted at the smallness of her family, and evidently thinking that the cat had more than her share, captured one of the kittens in the absence of the old cat, and carried it in her mouth to where she kept her pup, and deposited it in her basket. In a short time she was suckling both the pup and kitten, who were hard at work side by side. The next day the kitten was taken away in the absence of Simmons, but on her return she hunted up her adopted child, and brought it back to her basket, where it has remained until now. Simmons has now been nursing the kitten for more than a week, the kitten seeming to be perfectly satisfied with her foster-mother.

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